

Residential Panels Benchmark Requirements

September 2004



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Open-wall panel system used in Coachella, California

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Raw materials ready for fabrication into wall panels

Panel Research I: Wall Panels Benchmark and Requirements

Executive Summary

The broad purpose of this research is to define what panelized wall systems are currently available in the U.S. and international market, their technical specifications, how they perform and in what applications are they most used, and what are the standard performance criteria that all panelized wall systems need to meet in order to integrate with existing methods of construction. Collectively, this information is the industry “benchmark.” The study concludes with a “Future Strategies Report,” based on the research, on what direction HUD should take on future research into panelized systems.

The focus of the research is to provide a clear understating of the current condition of the wall panel market. The three areas of focus with in the wall panel market are systems types, code compliance, and performance measures. Research efforts included the development of a panelized system matrix, descriptions of various panel types, performance measures inherent in panelized systems, and areas of code compliance in panelized systems.

The research methodology employed helped to gain a first-hand view of how the panelized housing industry sees itself, the research challenges it needs to meet to sharpen its response to the market, and the standards necessary in order to compare systems of different manufacturers. The methodology included an extensive compilation of existing panel systems that are currently on the market; interviews with industry leaders; documentation of the panel systems in regard to performance, codes, existing standards, materials, connections, and availability; and the research needs of the industry in the future in the service of broadening the panelized housing industry’s impact on the market. The methodology employed extrapolated information and standards from existing panel systems that could be developed into performance criteria that would apply to the industry as a whole.

1. Benchmarking: State of the Art of Panel Systems

For the purposes of this research, panel systems are defined as those building components that arrive at the site either partially or fully fabricated, which are joined to other panels to create walls, floors, and roofs of a house. Investigation consisted of: searches on the World Wide Web; journal, book, and magazine reviews; inquiries to associations and journal editors; and conversations with various manufacturers including the Technical Advisory Group members. Conversations with journal editors and associations focused on standard panels systems, new innovative systems, and reference for further investigation.

Panel System Matrix and Panel Types

In order to establish a ground on which to move forward, research began with an inventory of all panel systems in the market to-date. The first step in the research was to canvas the panel industry to gage the state of the art in panel, in terms of the types of panels that are currently available on the market, the predominant materials used, and the composition of the panel systems. Documented were the types of panels traditionally used in residential construction as well as those used in other industries such as commercial, industrial, agriculture, automobile, landscaping, aeronautics, and boat/ship. Panels used in various industries were documented so as to capture technologies that may be applicable to or adapted for residential construction. Systems that are manufactured abroad were also noted. Some of the systems encountered were structural insulated panels (SIPs), concrete, wood, plastic, steel with concrete, honeycomb of various materials, and expanded polystyrene. All of the systems encountered were then entered into a matrix. Information describing components of the system included:

- System name
- Manufacturer
- General description of panel

- Current and potential application
- Skin material
- Core material
- Whether the panel was structural or nonstructural
- Connection technique
- Dimensions
- Cost
- Environmental quality characteristics
- Certifications
- Region of distribution

The first inventory of panel systems grew to more than 100 individual systems (the complete “Panel Types and Manufacturer Matrix” is found in the Appendix). After review by HUD and other involved in research, the categories used to define the panel systems were pared down to those considered the most important system components. System information was filled in where needed, and additional systems were added. The result was a more concise description of the various panel systems. Additional panel systems (several of them from Europe) were added to the matrix.

There were obvious similarities between some of the 110-plus systems listed in the matrix. Based on these similarities, 26 panel system “types” were defined. Similarities used to discern system types included panel skin and core material, including framing and stud material. The panel types are as follows:

- Aluminum/steel-rib system
- Carbon fiber
- Concrete – autoclaved aerated concrete
- Concrete – concrete skinned studs
- Concrete – hollow core precast
- Concrete – innovative reinforcement
- Concrete – sandwich
- Gypsum drywall

- Foam composites
- Honeycomb – metal
- Honeycomb – plastic
- Honeycomb – wood based
- Masonry
- Panelized framework
- SIP – aluminum cladding/foam core
- SIP – mineral fiber
- SIP – plastic
- SIP – plywood/OSB/gypsum/foam core
- SIP – steel/metal sheet/foam core
- SIP – stud
- Steel ribs
- Straw
- Stressed-skin panels
- Studs and skins – fiberglass or glass skins/aluminum studs or frame
- Studs and skins – wood studs/wood or drywall skins
- Wire mesh

A description of each panel system type was then created, with each of the more than 100 individual panel systems being assigned to one of the 26 panel system types.

Although not every panel system from the matrix was listed as an example, all panel systems fit within one of the 26 panel system types. The organization of the matrix allows for a general view of the different types of panel systems in the market, and a detailed view of the types of systems available. The matrix is a benchmark, a reference point, to help guide the discussion and debate during the rest of the research project.

The pages that follow document the 26 panel system types and the panel systems that are included in each type.

ALUMINUM/STEEL-RIB SYSTEM

Skin Material(s)

Aluminum, EPS, Polymer or Epoxy

Core Material(s)

Fluted Plastic, Steel Framing, Steel

Description

The system skin can vary depending on application. The core of these systems maintains a rib-type design, whether this is fluted plastic or corrugated steel.

Current and Potential Application

Structural/Nonstructural/Residential/Commercial/Exterior /Walls/Foundations/Truck Side Kits- These panel systems are used in residential and commercial construction. Because of their strength and durability, these panels are sometimes used for foundations, more specifically in the construction of prefabricated homes. Another testament to their durability is the use of these panels as truck side kits.

Connectivity

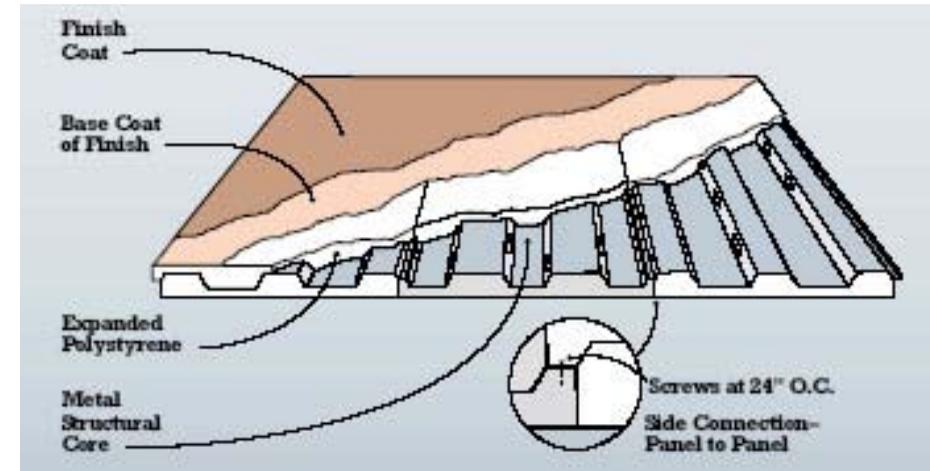
Panels are often attached with screws. The method by which adjacent panels fit together is specific to the manufacturer. Some have chosen a ship-lap design while others use a frame and track method.

Examples of Systems

ACSYS Inc. www.acsys.net

Fast Track Foundation System www.fasttrackfoundations.com

Aero-Kit Industries Inc. www.aeroindustries.com



Composite of panel materials



Aluminum and steel-rib panels in construction

CARBON FIBER

Skin Material(s)

Carbon and Epoxy Fibers

Core Material(s)

Carbon Fiber, Unidirectional or Graphite, Woven Material

Description

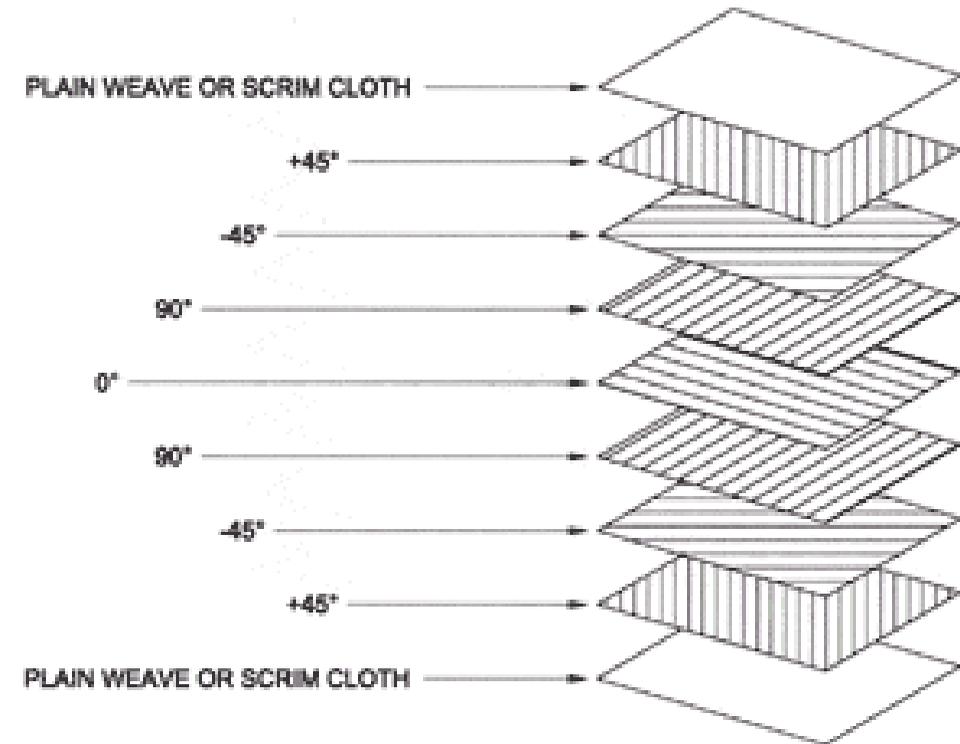
This is a 100% carbon and epoxy panel that uses unidirectional carbon fibers or woven graphite in the core of the laminate. This method of panel construction produces a panel with uniform thickness, consistent appearance, unparalleled flatness, and high durability. The strength and stiffness of each layer of the laminate closely follows the direction of fiber in that layer. By varying the direction of each layer of fiber, the panel characteristics can vary to insure desired performance.

Current and Potential Application

Structural/Industrial/Commercial/Interior /Semi-conductors/Automotive /Astronomy/Medical Device- The panel is used in the construction of commercial and industrial products. The ability to manipulate the performance of the panel is a unique characteristic that allows the manufacturer to produce various products.

Examples of Systems

Kinetic Composites Inc. www.kcinc.com



Layered composition of carbon fiber panel



Sample panel texture

CONCRETE - AUTOCLAVED AERATED CONCRETE

Skin Material(s)

Autoclaved aerated concrete

Core Material(s)

Autoclaved aerated concrete

Description

This panel is made of autoclaved aerated concrete (AAC), a mixture of sand, lime, cement, water and aluminum. The self-insulating panel keeps out termites, resists fire and stands up well to earthquakes.

Current and Potential Application

Structural/Residential/Commercial/Interior /Exterior/Wall - The structural panel is used for residential and commercial walls.

Connectivity

This panel can be manufactured to the exact size of project walls, eliminating the need for numerous panel-to-panel connections. The systems are flexible and are able to connect to various framing methods.

Examples of Systems

BABB International Inc. www.babb.com/int

YTONG www.ytong.cn

Oncrete Building Systems PTY Ltd. www.oncrete.com.au



Erection on-site of AAC concrete panels



Panels are stabilized by struts during erection process

CONCRETE - SKINNED STUDS

Skin Material(s)

Concrete

Core Material(s)

Steel Stud, Rebar

Description

This panel system consists of light-gauge steel studs that are connected to concrete. They most often use wire mesh or rebar as reinforcement. It is possible for panels to come with insulation but this is not standard practice.

Current and Potential Application

Structural/Residential/Commercial/Interior /Exterior/Wall/Floors/Ceilings/Foundation- The structural panel is used for residential and commercial walls, floors, and ceilings. This includes above- and below-grade foundation walls.

Connectivity

Most often, panels are bolted together and sealed with caulk.

Environmental Characteristics

Concrete walls are sometimes made with recycled aggregates such as fly ash or slag.

Examples of Systems

Earl Composite Systems www.metalcrete.com

Easi-Set www.easiset.com

Superior Walls www.superiorwalls.com

Kistner Concrete Products www.kistner.com



Finished house with concrete panel system



Concrete panels have open-wall of steel studs



Open-wall system allows access for utilities



Roof structure frames into concrete panels

CONCRETE - HOLLOW CORE PRECAST

Skin Material(s)

Concrete

Core Material(s)

Hollow

Description

This concrete panel is manufactured with a hollow core. There is an option to insulate the panel with appropriate materials, in which case a higher R-value can be achieved.

Current and Potential Application

Structural/Commercial/Exterior/Wall - This structural panel system is used for commercial exterior walls. If panel is insulated, it can be used for refrigeration facilities.

Examples of Systems

Fintech Precast Inc. www.fintechprecast.com



Concrete panel systems has both commercial and residential applications



Concrete panel core is hollow for utility chases and to lighten the members

CONCRETE - INNOVATIVE REINFORCEMENT

Skin Material(s)

Concrete and Glass-fiber Reinforced Concrete (GFRC)

Core Material(s)

Wire Mesh and Steel Framing

Description

This panel has a shell of concrete reinforced by wire mesh. The concrete shell can be a mixture of various materials and is determined by the manufacturer. The shell is supported by light-gage steel frame.

Current and Potential Application

Nonstructural/Residential/Commercial/Interior /Exterior/Walls- The nonstructural system is used for residential and commercial exterior foundation and above-grade wall construction.

Connectivity

Panels are bolted together and finished with a caulk.

Examples of Systems

Niradia Enterprises Inc. www.niradia.com



Glass fiber reinforcing provides exception strength in single-unit wall sections

GYPSUM DRYWALL

Skin Material(s)

Drywall

Core Material(s)

Drywall

Description

This is a solid drywall panel that can have conduit, socket boxes, and switches pre-cutout. The pre-cut chases for wiring etc., reduce the amount of wasted material.

Current and Potential Application

Nonstructural/Residential/Commercial/Industrial/Exterior/Interior/Walls- This type of panel is used in the construction of commercial, industrial, and residential projects.

Examples of Systems

Shui On www.shuion.com



Gypsum panels with preformed utility chases



Pipe connections in preformed gypsum panel

FOAM COMPOSITES

Skin Material(s)

Expanded Polystyrene (EPS) and Steel Framing

Core Material(s)

EPS, EPS and Steel Core

Description

These panels are composed primarily of EPS along with embedded material that gives it strength. A system may have an endoskeleton of galvanized steel embedded in molded EPS. The strength of the panel can be increased by incorporating one or more steel columns in the core prior to molding. A similar system may consist of rigid planks of solid EPS, reinforced with tubular galvanized steel struts and angled steel top and bottom corners.

Current and Potential Application

Structural/Residential/Commercial/Exterior//Roofs/Walls- This panel is used in the construction of commercial and residential walls. Sheetrock can be screwed directly onto the frame if available.

Connectivity

In some cases, panels are placed on a track and then slid into the adjoining panel ship-lap joint and screwed at base and top. This type of system allows for greater integration with other construction types; including pre-engineered steel frames, block, concrete, tilt up, and wood or steel framing.

Examples of Systems

R-Steel www.r-steel.com

Eco Therm Panel Systems Inc. www.ecothermalpanel.com



Steel and foam panels are lighter and easier to assemble



Single panel can be moved by two people

HONEYCOMB - METAL

Skin Material(s)

Steel, Aluminum

Core Material(s)

Aluminum, Polycarbonate, Polypropylene, Paper, Phenolic-Impregnated Kraft, Plastic, EPS, Urethane Foam, Extruded Polystyrene, Balsa Wood, ECA

Description

This is a lightweight and extremely rigid sandwich panel formed of metal skin material and a honeycomb core. The core can be made of various materials (see list above). The honeycomb core provides shear strength to the panel, while the skins add tensile and compressive strength. Utilities can be threaded through core material and cores can be filled with insulation.

Current and Potential Application

Structural/Commercial/Exterior/Interior /Walls/Floors/Boats/Airplanes- This lightweight structural panel is used in the construction of boats, airplanes and various other projects that require a lightweight yet high-strength panel system.

Connectivity

Connectivity varies with application.

Examples of Systems

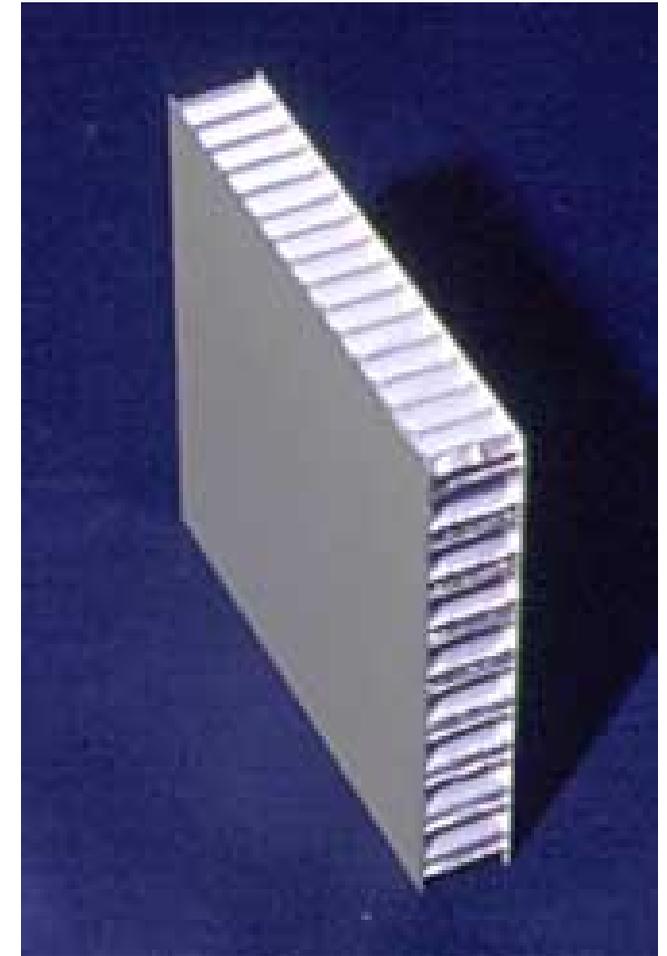
Bellcomb Technologies Incorporated www.bellcomb.com

Euro-Composites International www.euro-composites.com

Panel Projects www.panelprojects.com



Panels used in commercial application



Honeycomb panels of steel or aluminum

HONEYCOMB - PLASTIC

Skin Material(s)

Plastic Laminate, Polyvinylchloride (PVC), Fiber-Reinforced Plastic (FRP)

Core Material(s)

Aluminum, Polycarbonate, Polypropylene, Paper, Phenolic-Impregnated Kraft, Plastic, EPS, Urethane Foam, Extruded Polystyrene, Balsa Wood, ECA, FRP

Description

This is a lightweight and extremely rigid sandwich panel formed of plastic material and a honeycomb core. The core can be made of various materials (see list above). The honeycomb core provides shear strength to the panel, while the skins add tensile and compressive strength. Services can be threaded through core material and cores can be filled with insulation.

Current and Potential Application

Structural/Commercial/Exterior/Interior /Walls/Floors/Boats/Airplanes- This lightweight structural panel is used in the construction of boats, airplanes and various other projects that require a lightweight yet high-strength panel system.

Connectivity

Connectivity varies with application.

Examples of Systems

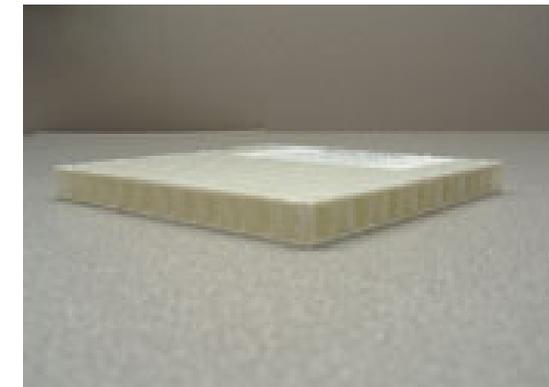
Bellcomb Technologies Incorporated www.bellcomb.com

Euro-Composites International www.euro-composites.com

Panel Projects www.panelprojects.com



Plastic honeycomb panels in fabrication



Panel skin and core of plastic materials

HONEYCOMB - WOOD BASED

Skin Material(s)

Balsawood, Plywood, Paper

Core Material(s)

Phenolic-Impregnated Kraft, Aluminum, Plastic, EPS, Urethane Foam, Extruded Polystyrene, Balsa Wood, ECA

Description

This is a lightweight and extremely rigid sandwich panel formed of wood-based skin material and a honeycomb core. The core can be made of various materials (see list above). The honeycomb core provides shear strength to the panel, while the skins add tensile and compressive strength. Services can be threaded through core material and cores can be filled with insulation.

Current and Potential Application

Structural/Commercial/Exterior/Interior /Walls/Floors/Boats/Airplanes- This lightweight structural panel is used in the construction of boats, airplanes, and various other projects that require a lightweight yet high-strength panel system.

Connectivity

Connectivity varies with application.

Examples of Systems

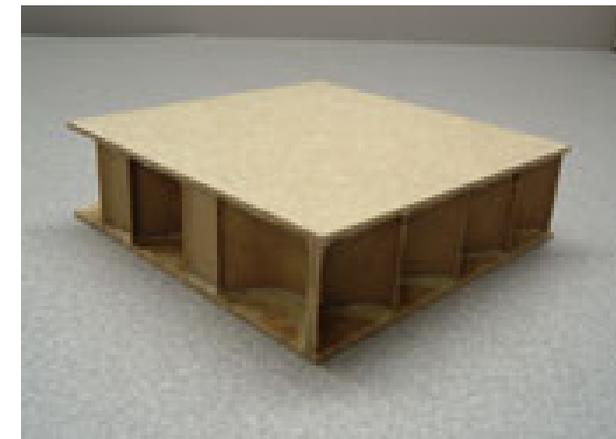
Bellcomb Technologies Incorporated www.bellcomb.com

Euro-Composites International www.euro-composites.com

Thai-Kiwi Marine Company Limited www.thaiboating.com



Wood-based panels in commercial application



Wood-based honeycomb is extremely lightweight

MASONRY

Skin Material(s)

Brick and Mortar

Core Material(s)

Bricks and Mortar with Steel Reinforcement

Description

This panel system consists of a wall of bricks reinforced with horizontal and vertical steel rods. Some wall systems have galvanized studded steel backing and foil faced mineral wool insulation.

Current and Potential Application

Structural/Commercial/Exterior/Walls- This panel is used to construct exterior commercial walls.

Connectivity

Typically the panel-to-panel connection is designed individually for each project. There are also gravity-frame connections every few feet.

Examples of Systems

Advanced Masonry Technologies Inc. www.advancedmasonrytechnology.com



Panel exterior is finished with brick-and-mortar



Brick-and-mortar panel being loaded from the factory for shipment

PANELIZED FRAMEWORK

Skin Material(s)

Concrete

Core Material(s)

Thastyron (recycled foam plastic and cementitious binder) and Rebar

Description

A Thastyron grid forms a honeycomb like framework. Rebar is placed horizontally and vertically through the grid and concrete is poured throughout the framework surrounding the rebar. This particular system uses less concrete than a typical concrete structural wall.

Current and Potential Application

Structural /Residential/Commercial/Exterior /Walls/Floors/Lintels/Retaining Walls- This type of structural panel is typically used in construction projects that demand a high-strength support system. This includes residential exterior walls, retaining walls, and commercial exterior walls.

Connectivity

Panels are initially connected with glue and/or clamps until the concrete is poured. Once the concrete has cured, it functions as the connecting device.

Environmental Characteristics

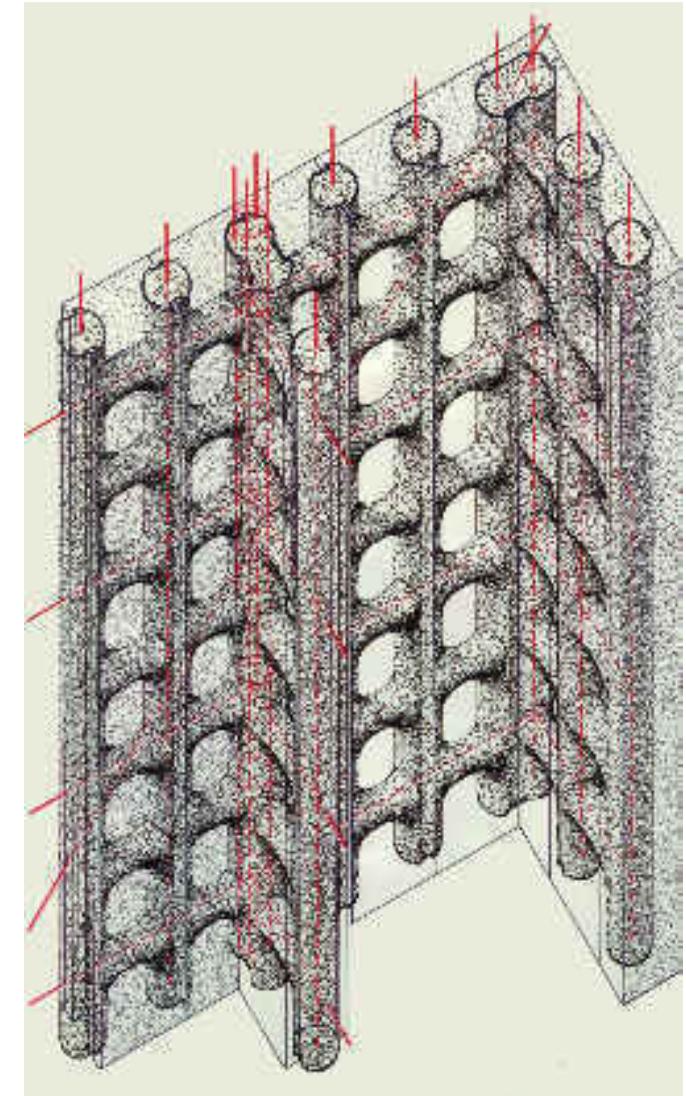
85% and more of the volume of the Rastra Block core is recycled material

Examples of Systems

Rastra www.rastra.com



Panels loaded for transport to building site



Wall core is of recycled plastic foam and rebar

SIP - ALUMINUM CLADDING/FOAM CORE

Skin Material(s)

Aluminum, Aluminum embossed material such as wood

Core Material(s)

Polyisocyanurate, Urethane, EPS

Description

This is an aluminum sandwich panel that can be filled with various types of insulative material. The aluminum skin material can be, but is not always, embossed into a material.

Current and Potential Application

Structural/Residential/Commercial/ Industrial/Exterior/Interior/Roofs/Walls- This structural panel system is used in the construction of walls and covers of both residential sites, such as a carport or walkway as well as a cover for industrial systems such as ductwork. The combination of durability and insulation makes this panel useful in industrial and commercial applications. An example of a common commercial application is the construction of cold storage facilities.

Connectivity

These panels may be connected metal to metal with pop rivets. Another option is a cam-lock system or a system in which internal gutter profiles allow the panels to be reversed.

Examples of Systems

Metal USA Building Products www.buildingproductsusa.com

Mortech Manufacturing Company

http://www.mortechmfg.com/mort_refrig_freezers.htm

APT Industries Inc. www.aptair.com



Patio shelter is a common use of this aluminum-clad panel technology



Aluminum finishes provide low or no-maintenance

SIP - MINERAL FIBER

Skin Material(s)

Steel, Aluminum

Core Material(s)

Mineral Fiber

Description

This system is composed of two sheets of steel surrounding an insulating mineral fiber.

Current and Potential Application

Structural/Industrial/Interior/Storage Facilities- This highly insulating panel is used in the construction of small and large cold and hot storage facilities.

Connectivity

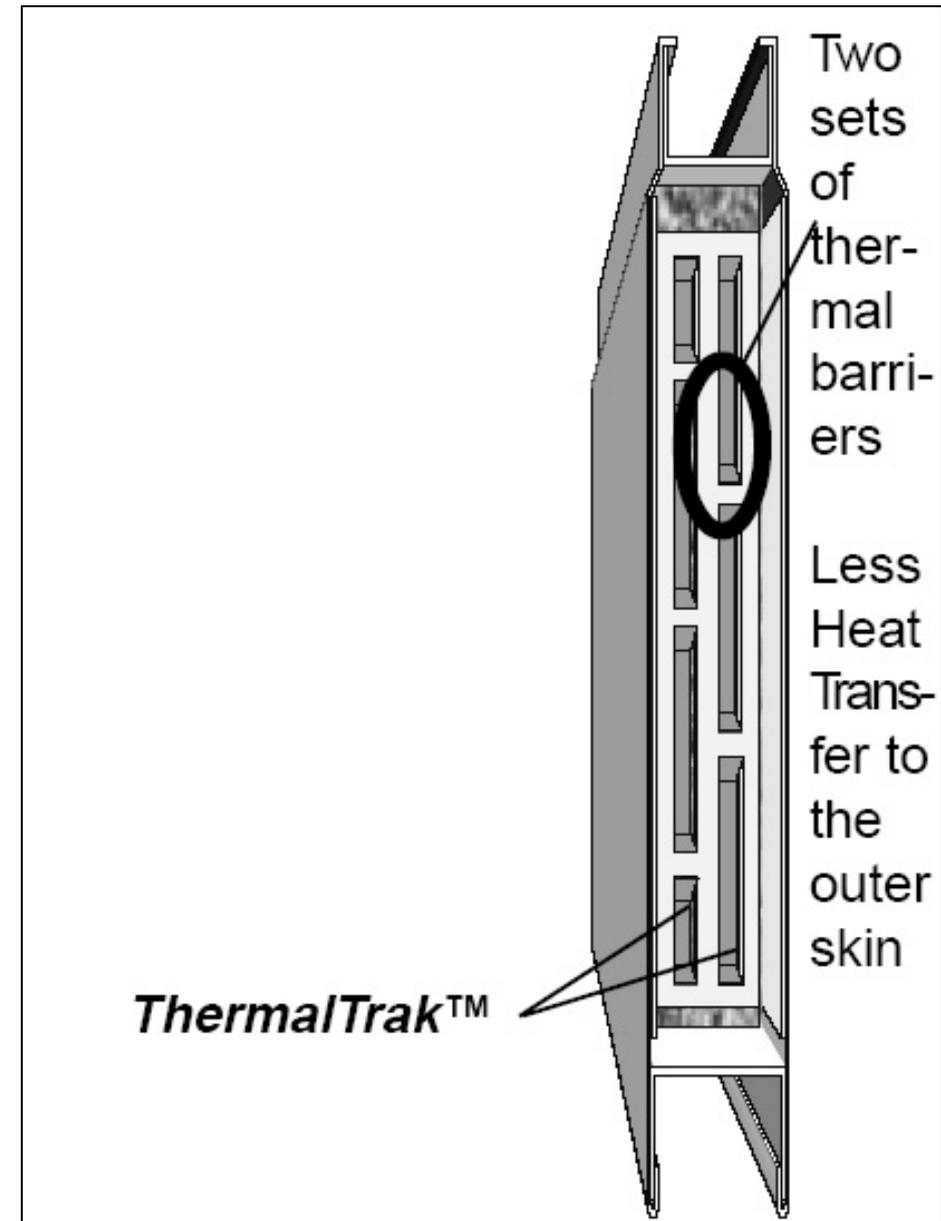
In order to reduce heat transfer, a “ThermalTrak” perimeter channel can be used. In some cases a tongue-and-groove system is used to connect panels.

Environmental Characteristics

Helps reduce heat transfer through the panels so that they are more energy efficient.

Examples of Systems

Eagle Panels www.eaglepanels.com



Mineral fiber core provides the panel's insulating properties

SIP - PLASTIC

Skin Material(s)

Plastic, Kevlar, Laminated Wood Fiber Board

Core Material(s)

Styrofoam, Polystyrene

Description

This is a high-strength panel system composed of durable plastic materials and insulation.

Current and Potential Application

Structural/Residential/Industrial/Exterior/ Interior/Roofs/Walls/Floors- Because this panel is so strong, it is often used in the construction of hurricane/shelter type structures. The panel maintains superior sound attenuation and is used in industrial applications that require the dampening of noise.

Connectivity

Panels are screwed together and anchored down.

Examples of Systems

Dupont, StormRoom

Warehouse Equipment and Supply Company www.warehouseequipment.com



Exterior surface of plastic provides a large measure of durability

SIP - PLYWOOD/OSB/ GYPSUM/FOAM CORE

Skin Material(s)

Gypsum, Cement-Bonded Particle Board, Plywood, OSB

Core Material(s)

Polyisocyanurate, Urethane, Divinycell, Pro-Balsa, EPS

Description

This lightweight panel is constructed of a wood fiber skin material and is insulated with various types of materials. The panel gets its strength from its wood exterior.

Current and Potential Application

Structural/Residential/Commercial/Exterior/Interior/Roofs/Walls/Floors- This structural panel system is used in the construction of walls, floors, and roofs of residential and commercial buildings. It is also used in the construction of furniture such as desks, tables, and cabinets, etc.

Connectivity

Panels are usually spliced together with a spline.

Environmental Characteristics

This panel can be made without the use of chlorofluorocarbons (CFCs) which have been linked to global warming. Of course this is dependent on the particular skin and core material.

Examples of Systems

Winterpanel www.winterpanel.com

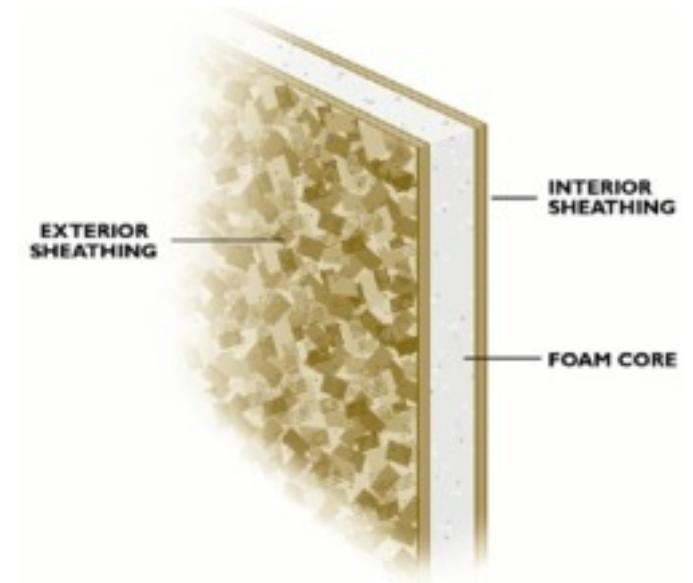
Murus www.murus.com

Insulspan www.insulspan.com

R-Control Building Systems www.r-control.com

Diab www.diabgroup.com

Agile Building Systems www.agilebuildingsystems.com



Structural insulated panels are used for roofs as well as walls, with pre-cut channels

SIP - STEEL/METAL SHEET/FOAM CORE

Skin Material(s)

Steel, Metal Sheets, Cement Board, Metal, and EPS

Core Material(s)

EPS, Celotex Rigid, Urethane, EPS, and Metal Studs

Description

This is a sandwich panel that has a metal skin and is filled with an insulating material. Both the skin and core materials vary with the manufacturer. Panels can come with an optional exterior finishing.

Current and Potential Application

Structural/Nonstructural/Residential/Commercial/Industrial/Exterior/Interior/Foundations/Ceilings/Roofs/Walls- This panel is used in the construction of commercial, industrial, and residential walls, ceilings, roofs, and foundations.

Connectivity

There is a variety of panels that fall under this system category, all of which come with their own connection system. Some panels are connected with a tongue-in-groove system while others use a shiplap joint and self-tapping tech screws. Top and bottom steel struts and snap-n-lock systems can also be found in the market.

Environmental Characteristics

Some of the systems use recycled steel and metal products. Others are recognized as Energy Star Partners.

Examples of Systems

Zero-Loc www.zeroloc.com

Kessel Construction www.kesselconst.com

GloPac glopac1@comcast.net

ThermaSteel www.thermasteelcorp.com

Structural Building Systems www.structall.com

Univision S.A. www.angelfire.com/biz/steelframe/panels.html

Zamil Steel www.zamilsteel.com



Metal-skin panels with insulating cores provide superior energy performance

SIP - STUD

Skin Material(s)

EPS and Steel Framing/Tubing

Core Material(s):

EPS

Description

Panels are highly insulated with an EPS core and are supported with peripheral and interior steel framing.

Current and Potential Application

Structural/Residential/Commercial/Exterior/Walls- This panel is used in residential and commercial construction.

Connectivity

Because the panel features framing members, panels are typically joined by screwing the members together.

Examples of Systems

Techbuilt Systems Inc. www.techbuilt.com



Panels of EPS foam interspersed with steel stud channels



System can be erected by small work crews

STEEL - RIBS

Skin Material(s)

Steel

Core Material(s):

Steel

Description

The panel consists of a solid steel outer skin that is welded to a channel frame and has a perforated metal inner core.

Current and Potential Application

Structural/Commercial/Industrial/Exterior/Walls- The structural panel is used for exterior walls of commercial and industrial facilities such as interior office, control pits, and shelters.

Connectivity

Typically used is a steel I-beam connection with top and bottom tracks.

Examples of Systems

Industrial Noise Control www.industrialnoisecontrol.com



Panels are relatively easy to assemble in interior partition applications



Completely assembled partition system

STRAW

Skin Material(s)

OSB, Paper Products

Core Material(s)

Agrifibers-- Straw, Wheat, Rice

Description

Panels are made of fibrous wheat, straw, or rice materials that have been extruded with heat and pressure and sandwiched between OSB or a paper skin material. This creates a high-density, durable, and fire-resistant product. The natural resins of the wheat straw create an extremely strong panel that can withstand heavy impact.

Current and Potential Application

Structural/Nonstructural/Residential/ Commercial/Interior/Exterior/Wall/Floors/Roofs- The panel is used for residential exterior and interior walls, floors, and roofs. Panels are also used in commercial construction.

Connectivity

Panels are nailed down to bottom plate and connected together with connection disks and adhesives.

Environmental Characteristics

An all natural insulation; non-toxic and non-corrosive.

Examples of Systems

Prestowall Design www.affordablebuildingsystem.com

Agriboard www.agriboard.com



Straw panels being raised into position



Panels can also be used for interior partition applications

STRESSED-SKIN PANELS

Skin Material(s)

Wood and/or other cellulose products with tensile and compressive strength characteristics.

Core Material(s)

Wood Frame

Description

The wall panel system is composed of wood skin that is connected to the wood frame system. The frame system varies with manufacturer and can influence the strength of the panel. Insulation is sometimes available, depending on manufacturer.

Current and Potential Application

Structural/Residential/Exterior/Walls- This structural panel is used for the construction of residential external walls.

Connectivity

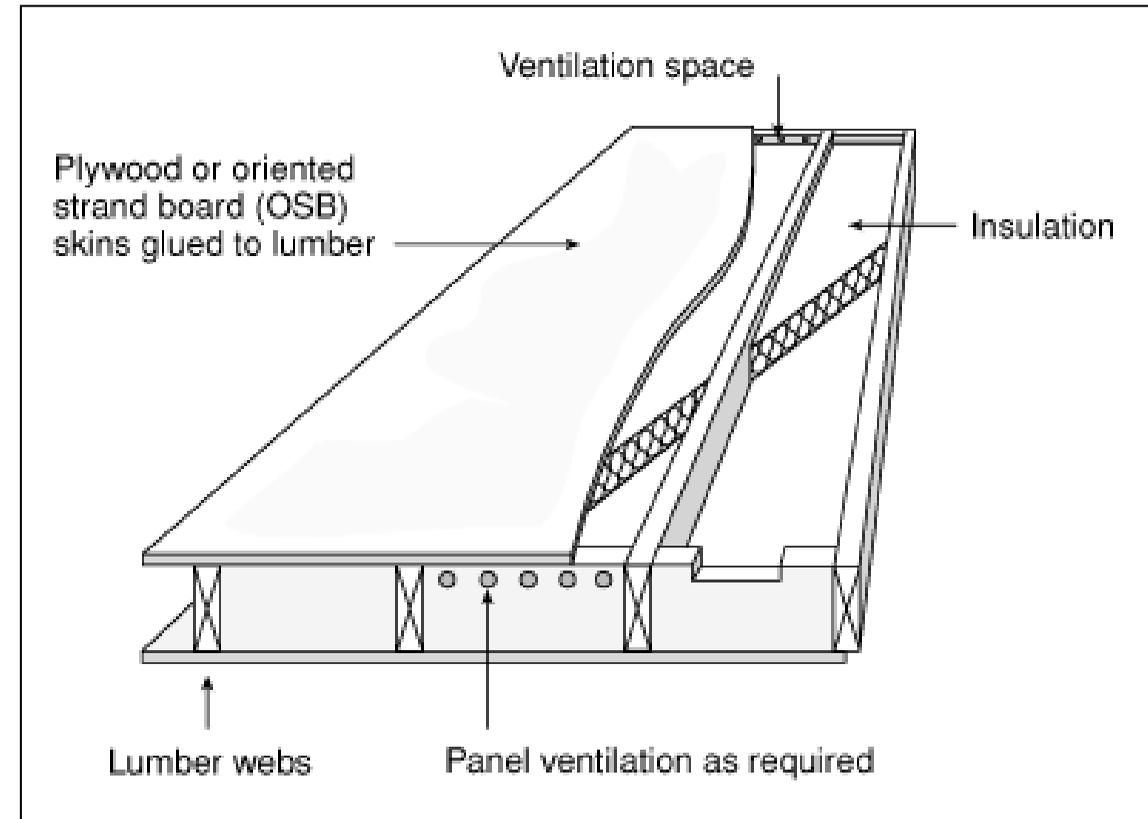
Panels can be manufactured for individual projects eliminating panel-to-panel connection. Corner panels are often connected with nails located beneath siding overlap.

Environmental Characteristics

Recycled and certified wood products can be obtained to construct panel.

Examples of Systems

Big Timber Works www.bigtimberworks.com



STUDS AND SKINS FIBERGLASS OR GLASS SKINS/ALUMINUM STUDS OR FRAME

Skin Material(s)

Fiberglass, Glass, and Metal

Core Material(s)

Metal Frame, Glass and Wood, Hollow

Description

This panel is available as a sandwich and a framed panel. The sandwich panel consists of a fiberglass skin material that is thermally bonded to a grid core, typically made of metal. The framed panel is made of a sheet of glass that is set in a metal or wood frame.

Current and Potential Application

Structural/Nonstructural/Residential/Commercial/Exterior//Roofs/Walls- This panel is used for the construction of translucent walls and ceilings (skylights) in residential and commercial buildings.

Connectivity

It is common for these panels to be set in a frame that allows for movement/opening of the wall or ceiling. The panels are typically bolted into the frame in which they are held.

Environmental Characteristics

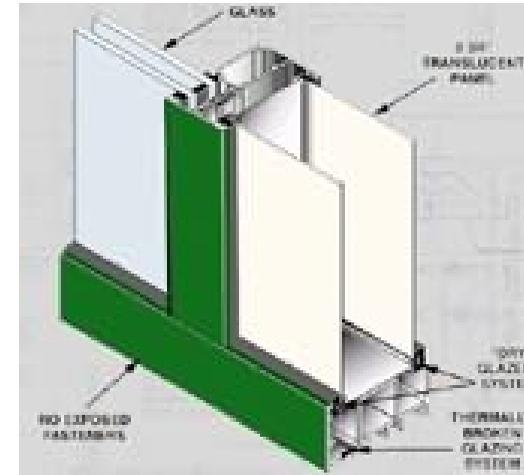
Although the panels themselves are not particularly environmentally friendly, they allow for natural lighting.

Examples of Systems

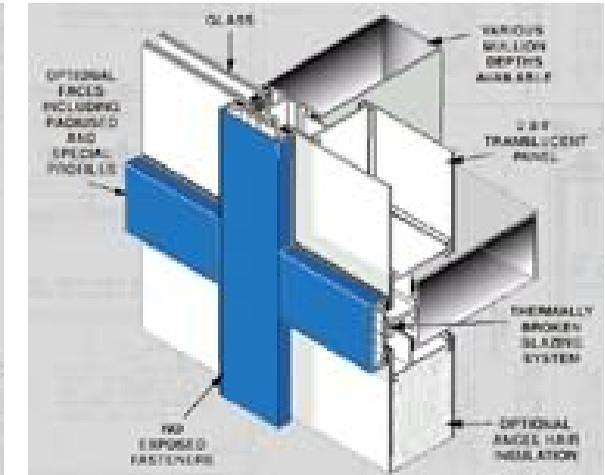
Kalwall www.kalwall.com

Skywall Translucent Systems www.skywall.com

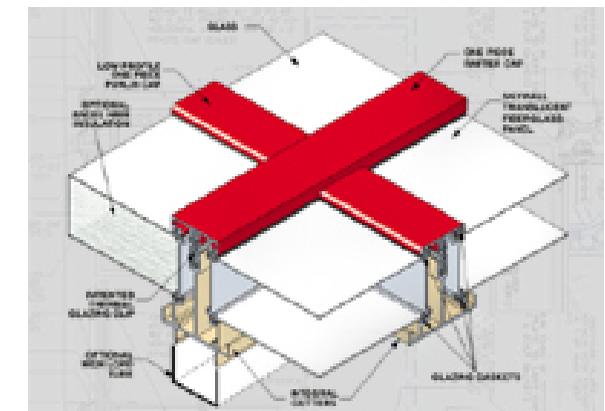
NANA Wall Systems www.nanawallsystems.com



Fiberglass and glass skin combination



Fiberglass translucent panel configuration



Translucent roof panel system

STUDS AND SKINS

WOOD STUDS/ WOOD OR DRYWALL SKINS

Skin Material(s)

Wood, OSB, Drywall

Core Material(s)

Wood Frame

Description

The open-wall panel system consists of wood or drywall sheathing and wood framing that is open for the insertion of utilities on site. The panel sometimes comes with insulation and pre-drilling for wiring. Typical framing consists of 2x4 or 2x6 members.

Current and Potential Application

Structural/Residential/Exterior/Interior/ Walls- This is a structural panel system used in the construction of residential interior and exterior walls.

Connectivity

Panels are typically connected with nails. They span the floor joists and are nailed down as well as nailed to each other. Panels can also be connected using a strapping system that is nailed down as well.

Environmental Characteristics

If panels are made of recycled material or materials are obtained from a certified sustainable lumber distributor, they have less of an impact on old-growth wood sources.

Examples of Systems

Deltec Homes www.deltechomes.com

Forest Homes www.foresthomes.com



Wood-based open-wall system is the closest technology to conventional stick framing



Exterior open wall panels with stick-built interior partitions

WIRE MESH

Skin Material(s)

Wire Mesh and Shotcrete

Core Material(s)

EPS

Description

Also known as a 3-D panel, this system consists of a three-dimensional welded wire frame utilizing a truss concept for stress transfer and stiffness. Each surface of the wire frame has a 2-inch-square welded mesh pattern of longitudinal and transverse wires of the same diameter. The expanded polystyrene core is placed between the two layers of welded wire fabric. The skin is welded and finished with shotcrete, which is a concrete material that is sprayed onto the wall at the job site.

Current and Potential Application

Structural/Residential/Commercial/Exterior/ Interior/Walls/Roofs/Ceilings- This structural system is used in the construction of residential and commercial exterior walls, roofs, and ceilings.

Connectivity

Panels are often connected to each another with wire ties or wire mesh sheets. Panels are placed over rebar and sprayed with shotcrete.

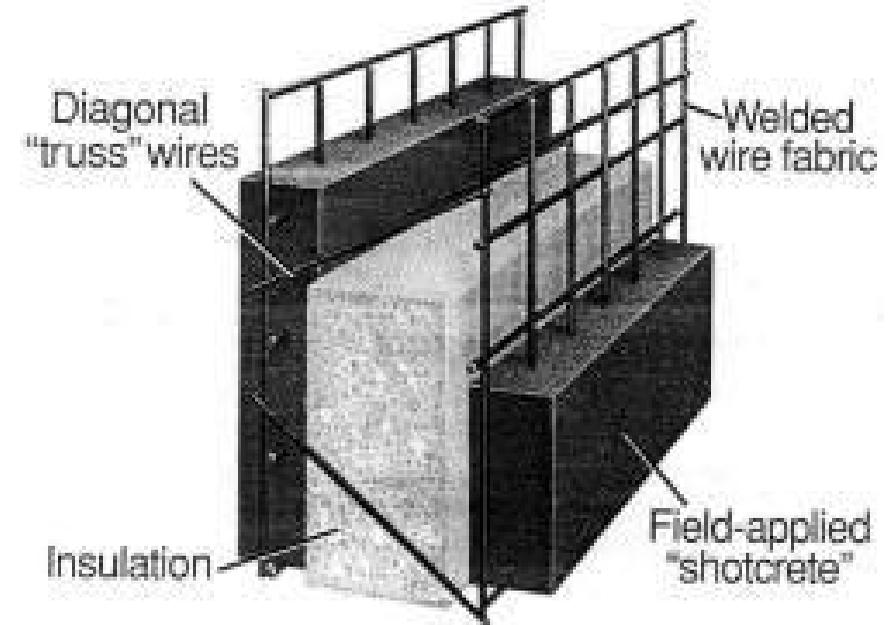
Environmental Characteristics

Recycled material such as wire is sometimes used in the construction of the panel.

Examples of Systems

Insteel Construction System www.3-dpanelworks.com

Hadrian Tridi-Systems www.tridipanel.com



Wire mesh and insulation is trimmed around window and door openings

2. Defining Performance Measures and Functional Integration

The next step in the research consisted of establishing a list of panel performance measures by which panels systems could be measure. The goal is to characterize panel systems in all of their physical characteristics, with an emphasis on characteristics that could be measured and recorded. The performance measures developed were organized under 12 categories:

1. *Safety and Fire Performance*

- Structure (shear, axial, bending, tension, point loads, surface loads, impact loads, lifting and transportation loads)
- Fire (smoke, fuel, flame spread, burn-through, noxious by-products)

2. *Weatherproofing*

- Moisture (penetration, degradation, mold, condensation, vapor-retardance)
- Wind (infiltration)

3. *Energy Performance*

- Thermal conductivity, radiation, mass, short-circuits

4. *Durability*

- Surface materials, degradation, corrosion

5. *Dimensions*

- Shapes, sizes, thicknesses
- Tolerances, variability, defining limits
- Dimensional stability under temperature and loading conditions

6. *Functions*

- Visual access (windows, privacy), solar access
- Acoustics (noise penetration, absorption)
- Obsolescence factors

7. *Connectivity*

- With other walls, floors, roofs
- With appendages, openings

8. *Penetrations and Inserts*

- Pipes, conduits, fixtures, structural supports

9. *Aesthetics*

- Surface materials, details and reveals, trim, color, texture

10. *Maintenance*

- Repainting, stain, metal corrosion, dirt removal
- Replacing degraded or obsolete elements

11. *Handling*

- Transportation, lifting, settling, relocation

12. *Flexibility*

- Relocatability

- Ability to be modified, remodeled, or replaced

The list of performance measures was further refined to 10 headings to focus the measures and to allow them to dovetail with code requirements, which would permit the performance measures to relate directly to relevant code citations.

1. *Safety and Fire Performance*

2. *Weatherproofing*

3. *Energy Performance*

4. *Durability*

5. *Dimensions*

6. *Functions*

7. *Aesthetics*

8. *Maintenance*

9. *Handling*

10. *Flexibility*

With the performance measures defined as they related specifically to panel systems, it becomes necessary to then dovetail the measures with applicable codes. This allows the measures to be used in determining if a certain panel system was code compliant in a variety of ways. In order to more clearly understand how the market is addressing these performance measures, the measures were broken down by those that are currently defined by code, those that have no formal definition, and those that are essentially not measurable.

For those performance measures that are currently defined by code, a matrix was created listing examples of applicable codes (as listed in the International Residential Code [IRC] and the International Code Council standard [ICC]), both general and specific. This code listing is not intended to be exhaustive, but rather to confirm that these performance measures are currently regulated in some way by a governing body.

1. Safety and Fire Performance

F i r e				
International Residential Code (IRC)			International Code Council (ICC)- applicable under particular circumstances	
R302.1 R302.3	Flame Spread	R319.1- R319.3	Surface Burning, Sandwich Panel Metal Skins AC214	3.4.1, 3.4.2 (reference to ASTM E 4)
	Fire Blocking, Wood Frame	R602.8- R602.8.1.2		
	Flame Spread, Insulation	R320.1- R320.5	Thermal Barrier Requirement, Sandwich Panel Metal Skins AC214	3.5 (reference to IRC R318.1.2, R318.3, IBC 2603.5, 2603.7) 3.6 (reference to 2603.5, 2603.5.4)
	Foam Plastic, Surface Burning	R318.1.1		

S t r u c t u r e				
International Residential Code (IRC)			International Code Council (ICC)- applicable under particular circumstances	
R301.1 R301.2	Allowable Stress, Masonry	R606.4 R606.4.1	Traverse Load Test, Sandwich Panels AC04	4.3.1, 4.3.3 (reference to ASTM E 72, 4.3.4-4.3.10)
	Lateral & Vertical Support, Masonry	R606.8- R606.8.2	Axial Load Tests, Sandwich Panel AC04	4.4.1-4.4.6 (reference to ASTM E 72)
	Wind Load	R301.2.1, R301.2.2.2- design R301.2.1.3- exposure R301.2.2- R301.2.2.6- seismic	Thermal Barrier Requirement, Sandwich Panel Metal Skins AC214	3.5 (reference to IRC R318.1.2, R318.3, IBC 2603.5, 2603.7) 3.6 (reference to 2603.5, 2603.5.4)
	Snow	R301.2.3		

2. Weatherproofing

Vapor Retarders With Insulation			
International Residential Code (IRC)		International Code Council (ICC)- applicable under particular circumstances	
R322.1		Mold, Sandwich Panel Adhesives AC05 as required by AC04	8.8-8.8.2 (reference to ASTM D 905, ASTM C 297) 8.8.3 (reference to ASTM D 1623)
		Weather Protection, Sandwich Panel Metal Skins AC214	3.3 (reference to IRC R703.1 and IBC 1403)

3. Energy Performance

Compliance			
International Residential Code (IRC)		International Code Council (ICC)- applicable under particular circumstances	
N1101.2 N1101.2.1- Type A-1 N1101.2.2- Type A-2	Insulation	N1101.3.1	
	Fenestration	N1101.3.2	
	Thermal Performance	N1102.1	

4. Durability

Compliance			
International Residential Code (IRC)		International Code Council (ICC)- applicable under particular circumstances	
	Decay (regional)	R323.1	Accelerated Aging, Sandwich Panel Adhesives AC05 as required by AC04
	Corrosion, Steel Framing	R603.2.3	
	Termite	R324.1, R324.3, R324.2	
			7.0-7.3 (reference to ASTM D 1183)

5. Dimensions

C o m p l i a n c e			
International Residential Code (IRC)			International Code Council (ICC)- applicable under particular circumstances
	Height	R305.1	
	Span, Wood Structural Panel	R604.2	
	Thickness, Masonry	R606.2.2	

6. Functions

C o m p l i a n c e			
International Residential Code (IRC)			International Code Council (ICC)- applicable under particular circumstances
	Acoustics	IBC 1207.1 -1207.3	
	Ventilation Outdoor	R303.1	

The matrix of code citations on this and the previous two pages does not include attributes that are difficult (if not impossible) to measure. Yet, these attributes should be included in the performance measures because they can assist builders and homebuyers in selecting panel systems. These attributes are organized in two broad categories, with detailed performance measures listed in each:

I. Practical Elements

1. Aesthetics:

- Surface Material
- Details and Reveals
- Trim
- Color Texture

2. Maintenance

- Repainting
- Stain
- Metal Corrosion
- Dirt Removal
- Replacing Elements

II. Elements of Connectivity

1. Handling

- Stacking
- Storage
- Lifting
- Moving
- Special equipment

2. Flexibility

Ability to be Modified
Ability to be Relocated

3. Dimensions

Shape
Size
Thickness
Tolerance
Variability
Defining Limits
Dimensional Stability Under Temperature and
Loading Conditions

Contacts and interview with various manufacturers and journal editors revealed that current code regulations and costs constrain the growth of panel technology and the adoption of the technology standard construction practice. This suggested that the panel industry might benefit from further research into areas that are barriers to technology adoption. The result of such a research program would yield a better understanding of what types of panel characteristics are important for panel performance and adoption. Understanding these performance measures could lead to increased panel utilization in the home-building industry.

3. Future Strategies for the Panelized Homebuilding Industry

The formulation of a comprehensive list of known panel systems in the U.S. and the identification and ranking panel performance measures became a point of departure in “blue-sky” visioning to identify what is needed by the housing industry, and the future research needed, in contrast to what exists or is on the horizon. Particular emphasis should be place on the differences between existing and needed research were emphasized in the process; many brainstorming meetings in the housing industry have included individuals calling for products and systems that already exist and coming up with ideas that have long been in existence.

The opportunity to conduct focused visioning with panel experts, industry representatives, and participants from HUD allowed the identification of what is truly needed in the areas of panel types, configurations, connectivity, finishes and other characteristics, and future research. The “blue-sky” ideas of improving the panelized housing industry are also tied to the daily realities of building houses in the U.S. market.

The major conclusions of the “blue-sky’ visioning run the gamut of issues that need to be addressed in current and future research, particularly supported by HUD. The key points of agreement and consensus among those in the industry are as follows:

- The goal of the current HUD research project is to identify technical research in homebuilding that would serve as a guide for government and industry. There have been a number of roadmapping activities, including advanced panelized construction. The vision is to develop building panels that perform multiple functions and integrate multiple tasks into a single process or step. Barriers to success are lack of familiarity with panels, initial cost of panels, wiring requirements, lack of standardization, lack of regulatory acceptance, limited distribution, transportation and handling, and factory inspection.

- Strategies to move forward include the development of advanced building panels; establishment of common standards and specifications (this is most important); and improvement of production, delivery, and site assembly. Future activities will include the exploration of efficient design concepts; connections testing and analysis; development of a full panelized model; development of a central resource center; development of training programs; evaluation of existing handling equipment.
- Options with panels are very wide: how they operate, connect, and are sheathed, and the different core materials. Innovations are taking place outside the housing industry with nontraditional materials such as carbon fibers. There are also combinations of materials.
- Labor and skills are the essential part, requiring constant retraining, the availability of labor, and staying within the industry. There is more interest from the building industry in modular technology. U.S. Census shows disparities of how many homes are built in the factory, but it is approaching 100,000 units a year, many of which are produced by large production builders. Many of the merchant builders are not using panelized systems. The numbers are down because stick building can be efficient if done in large numbers. Distributors such as Home Depot and Lowes are very effective in supplying materials at lower costs, and they are available everywhere across the country. They are moving the merchant builders more towards the stick-built process.
- Distribution of panelized systems is done mostly outside of the usual sources that builders are familiar with. One cannot go to Home Depot and buy a panelized system. Special channels are needed to acquire them.
- The decision to use panelized systems is more of a business decision than one of technology. The lack of qualified labor should be a major influence. It has not been to this point. The shortage of qualified labor gets filled by immigrant labor. This is supplied at the same or better quality. It is prevalent in the Sunbelt. Framing labor in Delaware is mostly Hispanic, coming in on a subcontractor basis. This trend is more of a challenge to the panel industry.

There are mega-framing contractors, who work all over the country, and know how to respond to the labor shortages in efficient ways.

- Open-wall panels, which basically involve the builder in using an open-wall package, have been more successful. Open-wall panels competition between the field framer and the panel supplier. The builder will pay a premium to obtain a total structural frame erected and in place. The industry must respond to that delivery system. Large production builders are using more open panel systems, coming from truss manufacturers. It is very prevalent in Mid-Atlantic market.
- Panelization is better because it is part of a better process. It is the same process as in the field, but the process is technically better because of the setting. The process benefits the consumer in some ways (such as energy efficiency) and also benefits the builder by allowing him to better control his process, and reduce call backs. There is also a design advantage. With CAD-CAM, more variety is possible.
- The insurance industry is making a bigger impact. It is now working with National Association of Home Builders, requiring inspections for fasteners, and requiring better oversight over the quality of the homes. The insurance industry is going to force to better quality and structural integrity.
- The building of the house is a process of selecting sub systems. This is one of the reasons that the labor content is different for the builder. The structural frame component is the biggest subsystem the builder has to address, and is what panelizers provide. Interconnecting the structural frame with the other systems, such as the foundation, utilities, etc., is important.
- There are fewer closed-wall systems being used now than 10 years ago. The driving force of the market does not encourage closed-wall panelization. An in-between product is closed exterior skin without the drywall. Those are the growth segments: sandwich panels and insulated concrete foundation systems (ICFs) are experiencing solid growth.

- Panel producers could help people to design with their panel systems; manufacturers could supply the CAD model. The CAD systems are often tied to a specific product. But if it is a commodity product, you can supply a design tool for the industry in general, and it can be adapted to different systems. Architects and builders are not getting the benefits of panelization without knowing the greater possibilities of design.
- The panelized industry should be developing a customized product that uses a commodity process of panelizing. Advanced panelization will come through a customized product. Using the factory process to go custom is the key. This is not a commodity product.
- The availability of heavy lifting equipment and other technology has made the modular housing market possible. Cost-effective mobile cranes would change the whole nature of panelization. Identifying potential expansion opportunities to have equipment manufacturers focusing more on housing technology and the market could make a difference.

The results of the “blue-sky” visioning, in addition to the inventory of panelized systems available and the drafting of the panel system performance measures, focused the research on “Future Strategies” that the panel industry and research institutions could benefit from—a candid view of the panelized industry, its needs, and how HUD might guide its research priorities in the future. The result is a “Future Strategies” discussion of what is *truly* needed in the areas of panel types, configurations, connectivity, distribution, education, and other issues, and suggestions of future research that might propel the panelization to make a greater impact on the home building industry. The issues, discussions, and recommendations are as follows:

1. Should HUD seek to set standards of performance in the panelized housing industry?

The home panelization industry has a good opportunity to now set the standards for panel performance that could generally raise the quality of the systems available (although it should be stated that the quality of panelization systems at this time is generally high. For example, a standard of performance such as the HERS (Home Energy Rating System) rating for a finished panelized house could be set above the current score of 86 to qualify for Energy Star compliance. Setting the bar above this rating, to perhaps a HERS score of 90, would generally raise the energy performance of panelized houses. Similarly, the bar could be raised on panelized housing system performance in relation to the International Construction Code, in ways that could be determined by a consensus of those in the panelized housing industry. Such actions would communicate to the industry and to consumers that panelized systems represent a higher-quality choice in the housing market, and would work to overcome inaccurate perceptions on the part of consumers that panelized housing is an inferior product, primarily because it is produced in the factory (when, in fact, the opposite is the case).

A model to consider would be past research funded by HUD on standardization in such industries as the steel framing industry. With HUD’s involvement as an impartial third party, it becomes more likely that such standards would be taken seriously by those involved in the industry, and encourage adoption.

Because a panelized housing system is a collection of subsystems that must work together, it is important for the professional organizations that represent the manufacturers of those subsystems to work together on standard-setting and adoption. An example would be the steel industry (which makes anchoring systems for panelized homes) and the concrete systems industry. Another example would be the broad standardization seen in structural insulated panel systems, which must also work with a number of subsystems. HUD’s sponsorship of such research, standard-setting, and adoption is key. Working with the professional organizations, HUD can foster adoption thanks to broad representation by those in the industry.

Another route to panel standardization and performance measures (particularly standardization among panel subsystems) might lie in the development and use of design tools (modeled on CAD software) that allows elements from different subsystems to be used freely with each other. Such design tools would encourage architects and developers to use a range of panelized systems and subsystems, for they would remove much of the guess-work of how different subsystems go together, and also what the design possibilities might be within different systems. Such design tools would make it easier to estimate the cost of a finished house that involves a variety of panelized subsystems that are outside of a standard package system (such as the Insulspan product). Each panel producer uses a different brand and/or type of CAD system. The systems are chosen for various different separate and/or combined functions; architectural, engineering, production drawings, etc. In many cases, the A&E software platform will interface with the main business system.

What augurs against the development of such design tools is that many panelized systems are designed to be used exclusively with certain subsystems, and that manufacturers naturally wish to protect their own panelized technology. As is currently the case in the industry, many CAD systems are often tied to a specific product. But if panelized housing is viewed more as a commodity product (such as 2x4s or pipe for plumbing) the design tool could be geared to the paneled housing industry in general, and could be adapted to a number of systems.

For example, a company such as Georgia Pacific could develop a library of panel systems of sizes or types that could be used and combined into different designs. Such a design tool would focus on the rules for how panels work together, and how subsystems fit into the overall system. Without such design tools currently available, architects and builders are not realizing the benefits of panelization, especially when it comes to design flexibility. Such design tools could also incorporate performance information (such as wind-design standards) that would help builders and architects to decide on the best system to use given the regional conditions. Such analysis of a system would then be affordable, and would not require third-party analysis, which tends to be costly (especially for small builders).

While many panelized housing manufacturers can take a design from an architect or builder and adapt it to a particular panelized system, this does not allow the architect or builder a full range of involvement in the process. Design tools that would allow architects and builders to explore possibilities, without needing first to approach a manufacturer, would bring these building professionals into the panelized housing design process.

Conclusions and Recommendations

Further research support from HUD could help the panelized housing industry to set standards of performance and use among the many subsystems that are found in a single panelized system. Such standards could promote the cross-use of various subsystems, and allow great variety in panelized homes. Design tools should be supported through research that would allow architects and builders to explore the possibilities within panelized systems, and would also aid in determining performance and cost. Such design tools would promote a greater use of panelized housing as a commodity product.

2. Should research focus on European systems and models from other parts of the world?

The creation of a commodity product that can satisfy the special needs of the housing market is an approach to panelized housing that one sees in Europe and Asia. The business model successful in Europe is providing the whole envelope, which results in far fewer headaches and uncertainty for the housing contractor. In these models, the entire end product, with all of its subsystems in place and working together, is provided by a single supplier, which also provides a guarantee that the installed envelope will perform according to certain standards. Because energy costs are higher in Europe and other parts of the world, there is a greater emphasis on envelope energy performance, and that is the primary standard by which many systems are selected.

Because of their cultural similarities to the U.S., England, Ireland, and Scandinavia might be good areas for further research in terms of the panelized housing products that they produce. Some companies in these countries are supplying upwards of 3,000 to 6,000 units per year, and they have the most to offer in terms of models from which U.S. manufacturers might learn. The Irish, for example, have done a very good job in designing and producing panelized home systems that provide a single solution, and communicating the quality of the system to the consumer. These promotional materials have been prepared by the Irish government.

Although the impact of panelized housing in Japan has been significant, there are fewer cultural similarities between this market and the United States. Japanese companies have attempted for many years to make the leap of exporting factory-produced houses to the U.S. market, with little success. However, just as Japanese cars made an impact on the U.S. market, and with generally high quality in their factory-produced houses, Japan may yet find a way of transferring panelized housing technology to the U.S. This might take the form of Japanese companies building panelized housing plants in the U.S. and running them like the auto plants. The key, however, would be to appeal to the values and images of housing that are special to the U.S. market. In this regard, Europe has culturally a closer relationship with the U.S. to understand what is here and what is needed.

Conclusions and Recommendations

The approach in Europe has been to design, produce, and market panelized systems as a total solution to housing needs. Individual systems are marketed on a commodity basis. Because of the closer cultural ties to such countries as England and Ireland, future research might look closely at panelized producers in these countries and study how they market their systems; the financing available; warranty systems; the involvement of builders, architects, and the end-users; customer satisfaction; standards governing these systems; and support from local and national government.

3. Is it worth exploring the goal of creating a customized panelized house using factory processes that operate on a commodity or standardized basis?

The panelized housing industry in the U.S. might be viewed as producing customized products by using a commodity process of panelization. Many believe that the advancement of panelized systems will only be possible by customizing the end product to the user's particular needs. Many industries approach such production in the same way. The auto industry, for example, offers base models that can be customized through a variety of different kinds of feature packages. Today, modular homes are offered on a customized basis, allowing the end user to modify the design and features before the fabrication of the modules begin. Industry experts believe that marketing panelized systems as a commodity is not in the best interest of the panelized housing industry. The key is to produce a quality product that can respond to the market. Advanced factory processes now allow each unit on an assembly line to be different, and cookie-cutter solutions are no longer necessary (nor are they desired by the consumer).

The efficiency of the panelized industry lies in its ability to produce a consistently high-quality basic unit—the panel, with its energy-conserving attributes and high quality construction—which can then be used in a variety of ways to create a customized housing solution consistent with what consumers want. Creating customized houses on a stick-built basis is not efficient. Wausau Homes, for example, believes that it is more efficient and effective to provide a customized product with standardized procedures, materials and quality control practices. Wausau's niche is more upscale housing. A stick builder can offer a better house if it is small and predictable—essentially the same design. But the panelized process can offer better quality with customization.

The question is to explore how the marketplace's demand for more customized products can be met by the panelization industry, in order to take advantage of this demand. In answering this question, it is important to overcome erroneous perceptions on the part of builders and others that a house produced in a factory is an inferior product.

Conclusions and Recommendations

The question of standardization versus customization is ripe for research. The panelized industry's ability to provide a customized housing solution using standardized elements is key to its further market penetration. HUD might support research that would explore how the best panelized producers have addressed this balance of standardization versus customization, how their successes are leading to a better, more market-responsive panelized housing product, and how those lessons learned could be widely disseminated.

4. Should HUD support testing, research, and analysis of panelized system connectors?

While connections between panels in a single proprietary system usually received extensive testing by the manufacturer, an area that could yield some interesting research possibilities is connections between subsystems. Research on connections between panels would necessarily need to be generic in nature, so that the research might be applicable to many different kinds of systems. Such research might not be particularly valuable (other than to the manufacturers of a particular proprietary system). However, research on connections between proprietary panel systems and their subsystems, such as the connections between Wausau's panelized houses and different kinds of precast concrete foundation systems, might yield lessons that can be applied on an industry-wide basis.

Most connections of wood-to-wood have been designed for 2x4 stick construction, and may not be applicable to panelized systems that use differently sized members to make up a panel. Panelized system manufacturers have specific needs for different connectors. Their applications are less generalized and more specific. For example, the width of a generic connector is sized for domestic lumber. But building elements such as micro-lams are differently sized. A connector suitable for 2x stick construction is not readily applicable to micro-lams. There is very little standardization, even among materials that are *supposed* to be the

same (such as 2x4s, which can vary slightly in size according to which mill produced them).

What is needed for such standardization is a market catalyst. An example of such a catalyst would be the auto industry, which early in the 20th century forced standardization of parts and pieces such as bolts and screws. At the end of the 19th century there were some 2,000 different thread connections for bolts and screws. The impact of the auto industry forced standardization of bolts and screws, which then extended to many other items that are used in auto manufacturing.

Conclusions and Recommendations

Connections between the subsystems of a panelized house, such as the walls and the foundation system, have not been given serious consideration. Doubts about connectivity between such subsystems might convince a builder or consumer to not use a panelized housing system. Research in this area could help to rationalize such connections, and could lead to great interconnectivity between systems in the industry. This would necessarily make the panelized house product easier to use, leading to greater penetration of the homebuilding industry.

While HUD has a limited impact on the industry, it could promote the idea of standardized connections between subsystems and other elements in panelized construction. Funded research could focus on models of interconnectivity that are currently available, identify the various subsystems that need to connect, and propose prototype approaches to achieving interconnectivity between subsystems. Other research activities might focus on: development of mechanical/electrical connections in panel connection design, details, and specs; develop and maintain listings of panel/connection systems; clarify criteria for uniformity of panels and their component elements, and support a standards-setting process; and standardize performance criteria so panels can comply at varying levels.

5. Could full-sized panel models offer benefits for the industry through testing and analysis?

The testing of a single panel of a system does not appear to offer a sufficient potential benefit in the testing arena. Testing a computerized model of a panel, or a computerized version of an entire house of a certain panel type, might yield more interesting and more valuable results. Such testing of entire systems might be especially valuable to builders, architects, and potential end-users of different panelized systems.

The key might be to define a half-dozen or more performance functions or performance attributes, endorsed by consensus within the industry, which could be tested across the range of different proprietary systems. Such testing could take place over the course of many months for such performance measures as energy consumption. Certain performance measures are dictated by code, so these are fairly straight-forward performance metrics to determine and collect data on. Others are not so easily measured, such as durability, dimensional tolerances, maneuverability, maintenance, and aesthetic criteria. Research into how to determine these more elusive criteria, and how to measure them, might be worthwhile.

Conclusions and Recommendations

Testing of full-scale panelized systems could be a valuable exercise in determining the various performance measures that might be applied to system functionality. Various experts in the field have noted that verifiable results among a number of performance measures could be valuable in the promotion of panelized housing technology to the building industry and consumers.

Where applicable, the agreed-upon dozen-or-so performance attributes should also be applied and tested on stick-built houses of comparable size, design, and location. The test results could be reported by a third party, such as HUD, without ranking the systems, as their performance would likely vary between different criteria.

This research could lead to an added benefit: comparable testing with stick-built examples would not only provide data on different construction types, but (if the results of comparisons of panelized houses to stick-built houses are favorable) could demonstrate the superior performance of panelized homes. The key would be to show that panelization makes sense from a performance angle. Energy consumption is the most obvious arena where panelized houses can compete favorably with stick-built homes, often exceeding the performance of stick-built construction.

6. Should HUD support the establishment of a Central Resource Center? Is there a place where builders or consumers can go for information on a panelized home technology and performance?

A Central Resource Center could be a valuable resource to builders, architects, and consumers, and others in the housing construction industry. For example, there have been a number of different studies on panelized housing providers, and panelized technology. However, there is no central data-base or website to access such information. HUD might offer seed money to research and determine the best format for such a Centralized Resource Center. While HUD might be unable to vouch for the accuracy of the information that could be accessed through the Center, HUD's involvement as a purveyor of the information and making it centrally available could help balance the information available—the good as well as the bad news. The establishment of a Central Resource Center would also give HUD a view of what information and research is out there and accessible, which could help shape future research agendas for panelized housing.

Conclusions and Recommendations

There is a need for a centralized source of reliable information about panelized housing systems, their performance, attributes, materials, features, etc. Existing research should be easier to access, and a Central Resource Center would be the perfect venue for the posting and distribution of such information.

The PATH website might be a good place to locate the Central Resource Center. This Resource Center might be simple to start, a place where one could find links to research and other information already available on the internet. As more research is commissioned and collected, it could be posted on the Central Resource Center site itself. Some of the information that could either be posted on this website, or accessed through it, might include: modular dimensional protocols for panels and their sub-elements, including dimensional tolerances; information on panels, connections, materials and their interconnectivity based on standardized protocols; and the best ideas, systems, and products from foreign sources. This site could also link to other professional organizations in industrialized housing.

7. Is training in the use of panelized systems a worthy goal? How would this help the process?

The general feeling on this subject is that training is the purview of the different manufacturers and panel systems, and that a “generic” training effort would not be feasible or helpful. However, it is emphasized that education of those in the housing industry and potential consumers is a worthy goal, as mentioned in other topics discussed.

Conclusions and Recommendations

Training in the use of proprietary panelized systems is not necessary (it is already supplied, for the most part, to builders by the manufacturers). HUD need not focus on training in the use of panelized systems. Rather education of many others in the housing field in regard to panelization is a worthy goal. The targets of such training and education would be appraisers, lenders, insurance companies, utilities, building officials, architects, builders, and foreign workers new to this market.

8. Should HUD support research in evaluating panel erection, transportation, and on-site equipment?

Panelized system elements are not as easily moved and manipulated on the project site as those used in stick building. Thus, panelized house systems often demand the use of specialized tools and equipment to assemble the house. Familiarity with these tools is essential, and research into tools and equipment that might facilitate the use of panelized housing systems might be a worthy research topic.

The interest in manipulating the elements of a panelized system extends to worker safety and preventing accidents on the job site. For example, the National Institute of Occupational Safety dedicates several millions of dollars a year to research worker safety. Panelized housing construction is ripe for injuries to workers, as the panels are heavy and cumbersome (back injuries are the greatest risk in moving panels).

The advancement and availability of heavy lifting equipment and similar technology has made technical advancement in housing possible—the modular housing market, for one, would not be possible without such equipment. Technologies such as cost-effective mobile cranes could change the whole nature of the panelized housing industry. Equipment manufacturers might view the panelized housing market as an area ripe for expansion if panelization were more dominant in the housing market. Ironically, if more heavy equipment were available, panelized systems would no doubt see greater use. This is the vicious circle of advanced housing technology.

Advanced equipment and tools can serve to make the process of erecting a panelized home on the job site more efficient, and is an area ripe with research opportunities. For example, tower cranes are making a huge impact on the panelized homebuilding industry. They have made the entire process more efficient. Research into the economics and use of technologies such as small power cranes, which can be employed all over the site and can contribute to the panelization process, might be worthwhile.

Technology tends to adapt to systems that are desirable in construction. For example, high-flow concrete is advantageous, and advanced pumping systems have been developed to further its use, particularly on job sites that have limited access to concrete trucks. Research on the panelization construction process on site might yield some insights into tools and equipment that would make the process easier and more efficient, and encourage the use of the technology.

One approach might be to focus on panelized construction companies such as NVR, which assembles the roof section on the floor deck, then installs the panelized walls, and picks up the roof sections after the walls are in place. On-site crane technology drives the efficiency of this process.

Conclusions and Recommendations

Research into the use of advanced technology for the movement and placement and panelized elements could yield greater insight into the efficiencies of panelization, and could encourage the use of this technology. HUD and OSHA might team together on research initiatives that would look at worker safety and job efficiency in the use of paneled home systems. The creation of new technology to satisfy a need on the panelized housing building site might be another focus. Studying how companies such as NVR employ technologies such as small and agile on-site mini-cranes might lead to new tools and equipment, and the promotion of panelized housing systems.

Research might also focus on the development of systems for integrating delivery and handling systems within the panelized construction cycle, as well as developing systems for accommodating weather cycles, just-in-time delivery, and other variables in the field. HUD might support research that would suggest optimized approaches to panel shipping, storage, distribution, delivery, and handling.

9. Three key strategies identified in the PATH road-mapping activity were: 1) to develop or design advanced panel technology; 2) to develop common standards and specs; 3) to improve production delivery and assembly. Should these strategies still be pursued?

These three strategies are still worthy goals. The importance of developing standards and performance specifications, working directly with the panelized housing industry, has already been mentioned. It is important that such standard-setting not be seen as determining the one, best answer, but rather as developing a range of answers or choices that can serve the consumer, builder, architect, and the panelization industry. The development of performance benchmarks would allow comparison of different panelized systems. Such benchmarks do not have to be complicated and should be performance-based, not prescriptive.

The design and development of advanced panel technology is perhaps best undertaken by the industry. One way that HUD might foster such development is to structure a research project similar to those offered as Small Business Innovation Research grants, which team independent researchers with industry professionals to explore new innovations in the field. Such research grants are usually structured as two stages: The initial grant supports research into technical approaches to new technology—essentially surveying the state of the art and the feasibility of different technical approaches. The second stage would devote more research funding to actually developing a prototype of the most promising technical approach. Such a prototype would then be tested in the field, results would be documented, and a plan would be developed for introducing the new technology to the industry.

The improvement of product delivery and assembly was touched upon in the above discussion of equipment and tools that could be used on the building site for assembly. Distribution and delivery of panelized systems is accomplished through a network of dealerships, usually involving the contractor and an end-buyer. It is possible that research might focus on raising the profile of the industry so that more consumers are aware of panelized houses as a market choice. Promoting the technology should be directed primarily toward documenting the

benefits of panelized housing technology compared to stick building. However, some panel producers might be reluctant to participate in testing, which will become public information and reveal their proprietary trade practices.

Conclusions and Recommendations

PATH has an opportunity to further the use of panelized housing technology by supporting of standards and performance measures, supporting the development of new panelized technology, and promoting the new technology in the housing market.

The authors suggest that research be supported with the goal of establishing 10 to 12 benchmarks for measuring performance. It is further suggested that HUD consider supporting research into the design and development of new panelized technology on a model similar to that used by the SBIR program. Finally, HUD might team with panelized housing industry representatives to explore ways in which consumer attitudes about panelized houses could be measured, and how perceptions of panelized housing might be changed for the better to promote the technology. Before acting on this recommendation, however, more input and evaluation is necessary from the industry.

10. How important is it for HUD to support information dissemination on panelized housing technology?

The dissemination of information about panelized housing technology was considered somewhat in the discussion about the Central Resource Center (above). It is agreed that information distribution is key to raising awareness of the technology and for educating consumers about the options available in panelized houses.

In most circumstances, an industry trade group best fills the role of information dissemination. However, the panelized housing industry lacks a trade group. The organization closest to fulfilling this role is NAHB's Building Systems Council.

However, the BSC does not focus exclusively on panelized technology; rather, it represents the broad field of industrialized housing systems (modular, panelized, etc.). BSC also does not promote research; rather, it is primarily a marketing and education organization. Having a connection with NAHB is a benefit because it puts the panel system manufacturers in contact with potential customers, but as one member of the Technical Advisory Group described the BSC, "It is a very small tail on a huge dog, and it doesn't get the recognition it deserves in NAHB." Some NAHB members also might see themselves in competition with panelized builders, which weakens the relationship.

Perhaps the strongest trade group in panelized housing technology is SIPA (Structural Insulated Panel Association). SIPA offers a wealth of information and materials on structural insulated panels, which is only one of many panelized systems now on the market.

Conclusions and Recommendations

The panelized housing industry is in need of a strong, recognizable professional trade association that will promote the industry and the use of panelized technology and disseminate information about it. Existing trade groups are either too narrowly focused on a single panelized system (SIPA), or represent many different kinds of industrialized housing technologies (NAHB/BSC). HUD could help support panelized housing technology by funding a third party to organize and operate a panelized housing trade group. The trade organization would promote the generic use of panelized systems (not one type of panelized technology, and not a specific manufacturer). Such a trade group also might encourage and support research on panelized housing technology and its use.



Dukane precast concrete panel systems in use in Chicago.

APPENDIX

Panel Types and Manufacturer Matrix

The following inventory matrix of panel systems includes more than 100 individual systems that were studied in the initial stages of the research. The types of panels listed represent a broad range of the panel systems currently available to homebuilders. A few of the systems listed are not primarily for the housing market, but my offer technologies that could be adapted to the housing industry.

The organization of the matrix allows for a general view of the different types of panel systems in the market, and a detailed view of the types of systems available. This benchmark matrix is a helpful tool in the discussion of the state of the art of the panelized housing system industry.

Panel Types and Manufacturer Matrix

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
1	3-D System	ICS (Insteel Construction Systems), USA, GA	Wire Mesh -3-D- This panel is a welded wire sandwich panel made of modified expanded polystyrene. The EPS is sandwiched between welded wire mesh. Once installed surfaces are sprayed with shotcrete.	Building- This structural systems is used in the construction of residential and commercial exterior walls, roofs, and ceilings.	Wire mesh - shotcrete	EPS - Modified	Panels are placed over rebar embedded in a concrete grade beam and fastened to one another with "hog rings" or wire ties. Every corner on both sides is covered with wire mesh and sprayed with shotcrete	Structural	Residential + Commercial	Interior + Exterior
2	3-D TridiPanel	Hadrian Tridi-Systems, USA, CA	Wire Mesh -3-D- This panels consist of a three dimensional welded wire space frame utilizing a truss concept for stress transfer and stiffness. Each surface of the wire space frame has a 2 inch square welded mesh pattern of longitudinal and transverse wires of the same diameter. The expanded polystyrene core is placed between the two layers of welded wire fabric. The skin is welded & finished with shotcrete.	Building-The Sstructural panel is used for the construction of exterior walls in both residential and commercial projects.	Wire Mesh, Shotcrete	EPS	A small wire mesh sheet 12" wide and 48" long is fastened over the panels with wire. The panels slide down over rebar which comes up from the floor, they are connected to the floor by concrete.	Structural	Residential + Commercial	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
1	3-D System	Varies by project	4"-6" Approx.	Wall, roof, and floor	\$1.65 to \$2.10		HUD approved, meet CABO one and two story family dwelling codes, Compliance report No. NER 0454, satisfies SBCCI, ICBO and BOCA requirements, SEB# 1120	International, popular in the hurricane region	2610 Sidney Linear Drive Brunswick, GA 31525 912-264-3772 Fax 912-264-3774 www.3-dpanelworks.com Spoke with Ed Hummel	Web	Was picked up by an Austrian company and brought back to the states.
2	3-D TridiPanel			Wall		Use recycled material			909 W. Vista Way Suite D Vista, Ca. 92083 www.tridipanel.com	Web	Individually welded internal strut wires or diagonals extend through the panel core between each surface. These galvanized strut wires are welded continuously in the required spacing so they form, with the welded wire fabric, into a triangulated truss, finished with applied shotcrete

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrail	Interior / Exterior
3	VIP (Vertically Insulated Panel)	Faromor Inc., International, Canada	A plastic skinned rigidly insulated panel that was designed to provide a non-interrupted opening which can be installed easily on new or existing barns. Manufactured with double glazed lites to allow extra light transmission during the colder months.	Agricultural-A nonstructural panel systems used to construct stable doors/walls both interior and exterior. The durability and good ventilation is advantageous.	Plastic- semi-translucent	Insulation - Rigid		Non-structural	Agricultural	Exterior + Interior
4	Tuff-Lite	Aero-Kit Industries Inc. ,USA, PA	Aluminum/Steel- Rib System, Aluminum- A lightweight heavy duty panel that consists of a fluted plastic core surrounded by a rigid aluminum panel guard.	Automobile- The nonstructural panels are used in the construction of truck side kits.	Aluminum	Plastic, fluted	Aluminum frame	Non-structural	Automotive	Interior + Exterior
5	Multilock	BOSS Motorbodies Int., International, New Zealand	Aluminum- Extruded aluminum wall panels with internal ribs that are a part of the panels themselves	Automobile- The nonstructural panels are used in the construction of the walls of a freight container on a freight truck.	Metal, Extruded Aluminum	Metal, Extruded Aluminum	Panels lock into one another vertically - side by side - and are attached by heavy duty fasteners top and bottom to the system's cant and coaming rails.	Non-structural	Commercial	Exterior
6	Pro-Fab EZ Lok	Metals USA Building Products, USA, TX	SIP- Aluminum Cladding/Foam Core - The expaned poly sytrene panel is coated with baked-on enamel finish.	Building- The nonstructural panel is strong enough to walk on and is used for residential roofing, patio covers, carport covers and walkway covers.	Aluminum, (heavy duty) .024" and .03"- Driftwood embossed	EPS- 1lb density	EZ lok- snap-lok with internal gutter. This type of system allows for panels to be reversed.	NonStructural	Residential	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
3	VIP (Vertically Insulated Panel)			Stables					(519) 625-8000 info@faromor.com P.O. Box 279 Shakespeare, Ontario Canada N0B 2P0 www.faromor.com emailed for info 12/1	Web	
4	Tuff-Lite			Truck side kits					Regional Location 2nd & Grand Street Hamburg, PA 19526 (610) 562-0260 www.aeroindustries.com	Web	
5	Multilock	Varies by project	Approximately 2.8mm	Truck wall					PO Box 14 609 Panmure Auckland New Zealand http://www.bossmotorbodies.co.nz/pages/content/index.htm	Web	
6	Pro-Fab EZ Lok	Width 2' and 4'	3-6"	Roof, patio wall , carports, and walkway covers					5085 W. Park Blvd., Suite 300 Plano, TX 75093 1-800-827-6045 www.buildingproductsusa.com	Ric Guilbert	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
7	Walk-In Refrigerator & Freezers	Mortech Manufacturing Company, USA, CA	SIP- Aluminum Cladding/Foam Core - The panels are a prefabricated poured-in-place urethane (rigid) insulated panel. The exposed exterior is .032"-thick stucco-embossed aluminum and the unexposed exterior is stucco-embossed galvanized steel.	Refrigeration- The structural panels are used for the walls and floors of mortuary refrigeration units.	Stucco-embossed aluminum + Metal Substrate	Urethane, rigid	Cam-lock	Structural	Commercial	Interior
8	Solid Laminated Panels	Kinetic Composites, Inc. USA, CA	Carbon Fiber- This is a 100% carbon/epoxy panel that uses unidirectional carbon fibers or woven graphite in the core of the laminate. This method of panel construction produces a panel with uniform thickness, consistent appearance, unparalleled flatness, and high durability. The strength and stiffness of each layer of the laminate closely follows the direction of fiber in that layer. By varying the direction of each layer of fiber, the panel characteristics can vary to insure desired performance.	Products- The panel is used in the construction of commercial and industrial products. The ability to manipulate the performance of the panel is a unique characteristic that allows the manufacturer to produce various products.	Carbon / epoxy	Carbon fiber, unidirectional OR graphite, woven		Structural	Commercial / Industrial	Interior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
7	Walk-In Refrigerator & Freezers	Varies by project	3"-5"	Mortuary refrigerators and freezers					45 La Porte Arcadia, California 91006 800.410.0100 626.447.8187 Fax: 626.447.0051 E-Mail: Info@mortechmfg.com http://www.mortechmfg.com/mort_refrig_freezers.htm	Web	
8	Solid Laminated Panels	Maximum sheet size of 48" x 96" Standard panel sizes: 12" x 18" - 38" x 50"		Semi-conductor; Automotive after-market; Astronomy Medical device; Sporting goods					1-800-375-7043 2520 Jason Court Oceanside, California 92056 E-mail: info@kcinc.com www.kcinc.com	Thomas Register	Not necessarily a qualifying system but a strong material type. Laminate.

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
9	Metal Stud Crete	Earl Composite System, USA, CA	Concrete- Concrete Skinned Studs - The MSC composite panels consist of light-gauge steel studs and a reinforced concrete facing or topping on one side of the studs, with the MSC metal connector providing a shear-flow connection between the steel studs and the concrete. A wire mesh provides exterior reinforcement. GFRC (glass fiber reinforced concrete) is supported by light gauge steel frame.	Building - The structural panel is used for residential and commercial walls, floors and ceilings.	Concrete + Reinforcing	Steel Frame + Insulation (upon request) typically batt insulation	Panel to panel (variations) - screw, rod and sealant.	Structural	Residential / Commercial	Interior / Exterior
10	Old Castle, uninsulated and insulated	Old Castle, USA, NY (owned by a company in Ireland)	Concrete- A Concrete panel with carbon fibers (TEchFab) and rebar for support. The panel is backed with expanded polystyrene. A new system being developed abroad.	Building / Other - A structural residential interior and exterior wall and floor system.	Concrete	Concrete (uninsulated) or Concrete + Insulation		Structural	Residential	Interior + Exterior
11	Fab-Crete	Speed Fab-Crete, USA, TX	Concrete- A concrete precast panel system reinforced with steel.	Building - Structural commercial and industrial exterior wall system.	Concrete	Concrete + Metal reinforcement	Steel framework is welded together and welded to bottom	Structural	Commercial + Industrial	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
9	Metal Stud Crete	10' or less: ±1/8", 10' to 20': +1/8", -3/16", 20' to 40': ±1/4"		Walls, floors, and ceilings			MSC is a patented ICBO approved steel connector strip connections. Minimum steel thickness and yield.	Technology sold to various manufacturer.	199 South Hudson Ave. Pasadena, CA 91101 Telephone: (800) 796-3275, ext. 62 Fax: (626) 796-6194 email: metalcrete@earlcorp.com www.metalcrete.com	Web	Additional detailed graphics on website.
10	Old Castle, uninsulated and insulated	Varies by project	Varies by project	Walls, floors, parking garages, bridges	Varies by project		Insulated: undergoing testing	International	100 County Route 101 South Bethlehem, NY 12161	Don Clem	Insulated: Is a new type of panel being developed by CarbonCast Consortium. It is a very lightweight, non-combustible, highly energy efficient precast concrete component for building systems.
11	Fab-Crete	8' - 14' wide, various lengths	3" - 8"	Walls			ASTM A 36		P.O. Box 15580, Fort Worth, Texas 76119 www.speedfab-crete.com	Web	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
12	Dukane Precast	Dukane Precast Inc. - involved with Building America, USA, IL	Concrete- Sandwich - A double wall precast concrete, with steel trusses girders connecting two sides. The panel is insulated with various types of insulation.	Building - The structural panel is used for exterior residential or commercial walls, and floors.	Concrete	Polyurethane, typically used + Soybean-based and other foam products are being explored as core material options.	Grouted together on inside and caulked on outside. Floor and ceiling cemented in.	Structural	Residential + Commercial	Interior / Exterior
13	Ecocrete Wall Systems	AFS Industries, LCC, USA, CA	Concrete- A glass-fiber reinforced concrete (GFRC) with steel studs panel. The pre-assembled stud wall is placed on top of a wet 5/8" GFRC slab, and molded in place with additional GFRC material.	Building - A structural residential and commercial exterior wall system, exterior finished in factory.	Concrete + Finish (exterior): stucco, aggregate or other exterior finish applied in factory.	Concrete, GFR + Steel studs	There are no fasteners or other penetrations through the exterior concrete wall. Panels are secured top and bottom to the structural steel frame and allow the flexibility needed in a relocatable structure.	Structural	Residential + Commercial	Exterior
14	Vertical Panel System	Leofric Buildings, International, UK	Concrete- A precast concrete panel. Panel designed for construction on a level concrete base.	Building - A Structural panel used for the construction of garage and shed exterior walls.	Concrete	Steel reinforcement	Panels are interlocked and are bolted together with rust resistant fixings. Bolts are screwed horizontally into the top and bottom of panels.	Structural	Residential	Exterior
15	Port-O-Wall	Port-O-Wall, USA, CA	Concrete- A precast concrete wall in which there is a "window" (a port) in the bottom of the panel for the pour-in-place foundation and rebar to go through to fully bond / connect with the panel.	Landscape- A structural commercial exterior site / landscape wall system.	Concrete	Concrete	Tongue-and-groove aid in alignment. The foundation and metal rebar go through the port ("window") at the bottom of the panel and stabilize it / hold it in place.	Structural	Commercial	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
12	Dukane Precast	Varies by project	Varies by project, typically two 3" panels with 2" gap for insulation	Walls and floors			In house testing, approved by local codes as projects complete	Midwest	1805 High Grove Ln. Suite 137 Naperville, IL 60540 630-355-8118 bbock@ducaneprecast.com www.dukaneprecast.com Spoke with Brian Bock 11/13	Don Clem	European technology. Can select from various textured external wall patterns. Unique finished internal wall. Looking to lighten up panel with slag and fly ash
13	Ecocrete Wall Systems			Walls			In accordance with the latest California Building Code	United States, United Arab Emirates, Nigeria, Mexico, and the Czech Republic	520 Parkway, Chula Vista, CA 91910 (619) 425-0044 ext.18 (619) 425-2751 fax www.ecocrete.net	Automated Builder, November 2002	
14	Vertical Panel System	7' high		Garage and shed walls				USA and Europe	Panelite Systems Inc. PO Box 578 Madison AL 35758 256-461-8000 www.garages-sheds.co.uk	Web	
15	Port-O-Wall			Site / landscape walls					585 Fifth Street West PMB 182 Sonoma, CA 95476 707.938.4516 - PHONE www.port-o-wall.com	Web	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
16	Highway Safety Barrier Connection System	Easi-Set Industries, USA, VA	Concrete- Concrete Skinned Studs - A precast concrete walls with an easy connect systems, JJ system.	Landscape / Site- Used to construct highway walls.	Concrete	Concrete	JJ hooks- wall ends line up (no male female ends, all ends fit together) and slide together completing the hook (see webpage for visual).	Structural	Industrial	Exterior
17	Insulstrux	Insulstrux Panel Company, USA, CA	Concrete- A prefabricated structural concrete insulating panel with expanded polystyrene core surrounded by wire mesh and a cementations skin. Concrete skin is typically field-applied, creating a complete system for construction of walls, floors, roofs and other load-bearing and non-load bearing structures.	Building - The panel is available as a load and nonload-bearing system. They are used to construct walls, roofs, floors.	Concrete, field applied.	EPS + Wire Mesh	Continuous high strength "W" truss with "C" ring fasteners to secure wire to trusses and panel to panel.	Structural	Residential + Commercial + Industrial	Interior / Exterior
18	ARES Panels	Tensar Corporation, USA, GA	Concrete- A steel reinforced precast concrete panel with compressive strength. The panel is made to the desired height, eliminating the need to stack panels. This panel meets AASHTO standards.	Landscape / Site- Used as retaining walls.	Concrete	Concrete	Tongue and groove	Structural	Industrial	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
16	Highway Safety Barrier Connection System	Varies by project	Varies by project	Highway wall barriers			Jersey and F-shape NCHRP-350 Approved		P.O. Box 300 · Midland, Virginia 227287 Toll Free: 1-800-547- 4045 www.easiset.com	Thomas Registry	It is the JJ hook technology that is licensed to manufacturers.
17	Insulstrux	Single panel widths: 2" to 12" - Single panel lengths: 8' to 20'+		Floors, walls and roofs.					24827 San Fernando Rd. #137 Santa Clarita, CA 91321 Tel (818) 612-9430 www.insultruxpanels.co m Mark David Heath 661- 586-6275 see builder benefits for information	Don Carlson, Automate d Builder	
18	ARES Panels	5' X 5' and 5' X 9'	5.5" to 8"	Retaining walls					5883 Glenridge Drive Suite 200 Atlanta, GA 30328-5363 800-TENSAR-1 www.tensarcorp.com	Web	Inserts high density polyurethane grid into the soil creating a solid mass. The grid connects to the panel holding the soil back.

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
19	Chameleon Cast Wall	Chameleon Cast Wall, USA, MA	Concrete- A thin-set veneer of architectural concrete masonry applied as a facer onto their cast concrete wall system. The facer may be any of a number of designs and can mimic various appearances, such as architectural block or thin-set brick veneer. The product is typically customized for the project as designed.	Building - A nonstructural exterior commercial facing panel for tilt-up concrete walls, which themselves typically are structural. Various facers available for the exterior.	Concrete	Concrete	Per standard practice for concrete tilt-up construction.	Non-structural	Commercial	Exterior
20	Hebel AAC Precast PowerPanels	BABB International Incorporated, USA, GA	Concrete- Autoclave Aerated Concrete, Concrete- Autoclave aerated concrete panel system.	Building - A structural or non-structural residential exterior wall system.	Concrete, AAC	Concrete, AAC	Connect to frame, method depending on framing system.	Structural and Non-structural	Residential	Exterior
21	External Wall Panel	YTONG, International, China	Concrete- Autoclave Aerated Concrete, Concrete- Autoclaved Aerated Concrete panel made of sand, lime, cement, water, and aluminum.	Building - A structural residential and commercial exterior wall system.	Concrete, AAC	Concrete, AAC	Cut to fit	Structural	Residential + Commercial	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
19	Chameleon Cast Wall				\$5/ft2 for the facer itself + cost of standard tilt-up concrete wall			Mid-Atlantic states, US	233 Harvard Street, Suite 316 Brookline, MA 02446 (617) 232-3354 http://www.chameleonwall.com/	Web	
20	Hebel AAC Precast PowerPanels	24" wide and 8' long	2" and 3"	Walls	2" = 1.23/sqft 3"= 1.85/sqft				2400 Hebel Blvd. P.O. Box 834 Adel, GA 31620 Main Telephone 229-896-1209 Spoke with engineer 11/18	Web	Can be easily attached to wooden or metal studs fitting into ordinary construction systems.
21	External Wall Panel			Walls					No 174 WuYi Road Shanghai, China 200050 021-52399600 Market@ytong.cn	Web	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
22	Fanwall	Reinforced Earth Company, USA, VA	Concrete- Fanwall® freestanding barriers consist only of concrete panels and aircraft-grade stainless steel cable connectors. They require no posts, footings, pilings or other costly supports	Landscape / Site- These structural panels are used for barrier walls, for example along side highways. Their ability to be rotated varying degrees makes this technology valuable.	Concrete	Concrete	Panels fit together in a hinge like fashion, they are rotateable	Structural	Commercial + Industrial	Exterior
23	Monotech	Monotech, USA, CA, NC, TX	Concrete Mix- Polystyrene forms are covered with Monocrete to create a rigid form. The interior and exterior is coated with a 1.2" layer of Monocrete. Monocrete - a structural material which is almost 3 times stronger than conventional concrete, cures to a strength of approximately 2,000 PSI in just 2 hours (to a strength of approximately 7,500 PSI in 28 days). The Monocrete can be sprayed or hand troweled onto the EPS foam.	Building - A structural panel used for exterior residential walls.	Concrete - Monocrete	Polystyrene	"C" and "H" Tracks: The panels fit into the "C" and "H" shaped metal tracks to compose a secure structure.	Structural	Residential	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
22	Fanwall			Sound barrier, transportation, utility, industrial and commercial installations					Corporate Headquarters The Reinforced Earth Company 8614 Westwood Center Drive, Suite 1100 Vienna, VA 22182-2233 www.reinforcedearth.com emailed requested info 12/4 received 12/9	Web	
23	Monotech	Varies by project	Varies by project			Non-toxic recyclable material as framework			24 Greenway Plaza Suite 1808 Houston, Texas 77046 USA Tel: 713 . 888 . 0507 emailed for info, 11/7 Got a phone call from Dan Diamon 713-888-0507 11/20	Web	The walls of the house are erected using pre-cut and labeled EPS foam panels and metal tracks.

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
24	Slender Wall	Easi-Set, USA, VA	Concrete- Open wall panels composed of architectural 2" thick precast concrete, hot-dipped galvanized welded wire, insulated Nelson® anchors (THERMAGUARD™), and heavy-gauge galvanized or stainless 6" steel studs to create a single, efficient exterior wall system.	Building - A Structural panel used in commercial exterior wall systems.	Concrete + Galvanized welded wire + 1/2" air space (created by Nelson anchors - reducing thermal transfer)	Metal Frame, galvanized or stainless steel + Plus Insulation, as desired.	Bolted, but frame and exterior free to move - alleviates thermal expansion / contraction movements	Structural	Commercial	Exterior
25	Xi Wall (in progress) & R-5	Superior Walls, USA, PA	Concrete- Concrete Skinned Studs -Open-wall system for below grade (above grade system as well) construction with interior material of DOW Styrofoam. The new wall is monolithically poured and reinforced with steel rebar and polypropylene fibers. A 1-3/4" face shell of concrete is laid over the DOW Styrofoam insulation. Inside may be finished per design on concrete studs (R-5) or on the galvanized steel stud facing (Xi).	Building - The structural panel is used for residential exterior foundations and above grade foundations.	Concrete + Styrofoam	Concrete + Rebar	Caulk and bolt.	Structural	Residential	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
24	Slender Wall	Varies by project, though TYP is approx. 8' X 20'.	8-1/2"	Walls					Easi-Set Industries P.O. Box 300 · Midland, Virginia 22728 Toll Free: 800-547-4045 email: info@EasiSet.com www.easiset.com	Thomas Register	Fairly complete system, siding and structure. Systems weighs 28lbs/ft2 (vs. traditional 85lbs/ft2 for concrete panel).
25	Xi Wall (in progress) & R-5	Height- 4', 4'-8", 8'-2", 9', 10'		Foundation and above grade foundation walls		Xi-Meets or exceeds energy conservation requirements from both the IECC and the IRC			Phone: 800-452-9255	Web	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
26	Precast concrete	Construcciones Industriales de Nuevo Laredo , International, MX	Concrete- Precast insulated concrete panels.	Building - Structural commercial and industrial wall and floor panels.	Concrete: One side is hand worked troweled mortar finish and the other is metal form smooth.	Polystyrene	The panels have 6 embedded anchor plates located on the edges of the panel facing out.The panels are welded to each other at intersections and middle points. Panels are also welded to the columns.The anchor plates are connected to the internal steel to transfer the loads to the main panel reinforcement.	Structural	Commercial + Industrial	Interior / Exterior
27	Rastra	Rastra, USA, AZ	Panelized Framework - Thastyron, a lightweight honeycomb mixture of EPS beads, forms a framework grid Concrete is poured through/around the matrix. Rebar is placed vertically and horizontally through the framework to give extra support.	Building + Landscape / Site- The structural panel is used for residential exterior walls, retaining walls, and commercial exterior walls.	Thastyron	Concrete + Thastyron Grid + Rebar	Glue or clamp until concrete poured. Concrete then holds panels together.	Structural	Residential + Commercial	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
26	Precast concrete	Height up to 3.2 mt, width up to 11 mt	Up to 6" thick	Walls and floors	\$82 US/sqmt and includes openings			Mexico border region.	5901 McPhearson Suite 9B Centre Plaza Laredo, TX 78041 956-728-7003 www.cinl.com gmartinez.cinl.com	Web	CINL's patented insulation prefab concrete panel walls are designed to accommodate future expansion (expansions will integrate seamlessly with the original building) of the majority of our buildings. Also construct a condensation resistant concrete panels. These are for buildings that require low temperature and humidity environments.
27	Rastra	15" or 30" X 7.5' or 10' long	8.5", 10", 12", 14"	Residential, shear walls, stem walls, lintels, retaining walls, and floors	\$23-\$75/element	85% of volume is recycled post consumer polystyrene waste		USA, International	7621 E. Gray Road Suite A1 Scottsdale, AZ 85260 (877) 935-3545 Info@rastra.com www.rastra.com emailed for info 11/7, received info 11/11, left message 11/11	Web	Typically, panels are constructed on site but prefabricated panels are also available.

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
28	Thermal-Krete	Kistner Concrete Products, USA, NY	Concrete- Concrete Skinned Studs - The panel is a combination of raw materials and a 5000psi concrete mixture of environmentally friendly, recycled flyash, strengthening fibers, and steel rebar. Panels come with steel framing on the interior face. Every panel is "monolithically" poured and cured by steam. The header/sill plate, footer, face and prestudded ribs are all one solid piece of concrete. Corners are also designed and supplied as one solid piece creating a seamless panel.	Building- The structural panels are used for subgrade exterior walls in residential buildings.	Concrete, 5000psi	Concrete + Steel Frame		Structural	Residential	Exterior
29	Cyclone	Oncrete Building Systems PTY Limited, International, Australia	Concrete- Autoclave Aerated Concrete - The panel is made of autoclaved aerated concrete (AAC) panels. This modular, prefabricated and inexpensive technology creates highly efficient, self-insulating structures that keep out termites and fire and stand up well to earthquakes.	Building- Applications include medium-density housing aged care and tourist accommodation industrial cool rooms.	Concrete, aerated	Concrete, aerated		Structural	Residential + Commercial	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
28	Thermal-Krete			Walls		Use recycled flyash			8713 Read Road, P.O. Box 218 E. Pembroke, New York 14056 (585) 762-8216 www.kistner.com	SWA is testing product	
29	Cyclone			Walls					Australia www.onecrete.com.au Email: onecretebuildingsystems@bigpond.com		

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
30	SteelCrete	Simple Building Systems, Inc., USA, CA	Concrete- The panel is made of concrete slab with imbedded wire mesh. The light gauge metal studs are attached to the concrete by an L tab that is punched out of the side flange of the studs and plates. The tabs are embedded into the concrete by using the building slab as a casting bed.	Building- The structural panels are used for exterior walls in residential, and commercial construction.	Concrete	Wiremesh and Light Gauge Metal Studs	Sent email 1/8/04	Structural	Residential + Commercial	Exterior
31	EIFS	Niradia Enterprises Inc., USA, CA, and Canada	Concrete- Innovative Reinforcement -The panel is a thin shell of concrete reinforced by wire mesh and supported by light-gage steel frame connected to GFRC (glass-fiber reinforced concrete) with stainless steel anchors. This is an open wall system.	Building - the nonstructural system is used for residential and commercial exterior foundation and above grade wall construction.	Concrete + Metal : Wire mesh reinforces GFRC (glass fiber reinforced concrete) and supported by light gauge steel frame.	Steel framing	Caulk and bolt	Non-structural	Residential + Commercial	Exterior
32	Drywall Panel with Concealed Conduit	Shui On, International, China	Gypsum Drywall - Conduits, sockets boxes and switches are precast into a drywall panel.	Building- Panels are used in the construction of industrial walls. This system reduces the amount of wasted material created when digging out chases for wiring, etc, reduced panel damage, and allows for a more accurate installation of wiring.	Drywall	Drywall		NonStructural ?	Industrial	Interior + Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
30	SteelCrete		1.5" to 2"	Walls					27280 Jefferson Ave, Suite 202 Temecula, CA 92590 www.simplecrete.com	Web	
31	EIFS	Varies by project		Walls	Varies by project			Canada and California	9424 Chesapeake Drive Suite 1303 San Diego CA 92123 858- 499-8970 www.niradia.com	Web	Though "non-structural" this panel can "hold a little weight".
32	Drywall Panel with Concealed Conduit	Varies with project	Varies with project	Walls				China, The company works on projects all over the world; not certain if panels are shipped all over.	emailed for info, 11/5. Information available at http://202.66.146.82/listco/hk/shuion/annual/2000/innovation.pdf and http://www.shuion.com	Web	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
33	Genesis Concept I Hi-Tech	Genesis Building System, USA, WA	EPS- A "post and beam" system within extruded polystyrene panel wall. The wall is given strength from the PVC pipes with concrete and rebar that are placed within the EPS.	Building - A structural residential exterior panel wall system.	EPS, The polystyrene has furring strips for attaching siding.	EPS + PVC + Concrete- PVC pipes with concrete and rebar are placed within the EPS as the structural framing.		Structural	Residential	Exterior
34	R-Steel	R-Steel, USA, ID	Foam Composites - An endoskeleton of engineered, galvanized 16-20 gauge steel embedded in molded expanded polystyrene insulation. The strength of the panel can be increased by incorporating one or more steel columns in the core prior to molding.	Building - A structural residential and commercial exterior wall panel system.	EPS	EPS + Steel - 16-20 gauge galvanized corrugated structural core, embedded in the EPS using a specialized molding process, attached at top and bottom with 18 gauge galvanized steel tracks	Panels are placed on a track and then slid into the adjoining panel "ship-lap" joint and screwed at base and top. The R-Steel Panel System readily integrates with other construction types; including Pre-Engineered Steel Frames, Block, Concrete, Tilt Up, and Wood or Steel Framing.	Structural	Residential + Commercial	Exterior
35	EcoTherm	Eco Therm Panel Systems, Inc., USA, PA	Foam Composites - Panels consist of rigid planks of solid expanded polystyrene (EPS), reinforced with tubular galvanized steel struts and angled steel top and bottom corners.	Building - A structural residential exterior wall and roof panel system	EPS + Steel, galvanized structural tubular struts / framing	EPS	Screw	Structural	Residential	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
33	Genesis Concept I Hi-Tech								PO Box 1996 Shelton, WA 98584 360-426-0145 genesis@olywa.net	Bill Zoeller	Cut into polystyrene where you need to place wiring and piping
34	R-Steel	2' and 4' X 18'	6" or 8"	Walls			UBC 26-3, ASTM E455, ASTM 1592, ASTM C578		9297 N. Government Way, Suite G Hayden, ID 83835 Phone: 1-866-8-RSTEEL Fax: 208-772-5942 info@r-steel.com	Rural Builder, September 2001	Acscys links to the R-Steel webpage.
35	EcoTherm	40' x 9'	7-1/4" thick	Walls and roofs					RR 1, Box 1850 Saylorsburg, PA 18353 http://www.ecothermalpanel.com/buildingsystem.html	Web	Can apply various types of siding. Sheetrock is screwed directly into the steel frame

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
36	EPS Insulated Panels	Zero-Loc, USA, WA	SIP- Steel/Metal Sheet/Foam Core - Expanded Polystyrene insulation manufactured by Zer-O-Loc under the brand name Zelsius EPS. Interior: panels clad with 26 gauge prepainted high-gloss white (QC5216 White Appliance Polyester or approved alternate) G90 galvanized steel (USDA & CFIA accepted). Exterior: panels clad with 26 gauge 8000 series (QC8317) white, USDA white, (or approved alternate), pre painted stucco embossed G90 galvanized steel.	Building- A nonstructural panel used in the construction of exterior and interior commercial walls, floors and ceilings.	Steel	EPS	Tongue-in-groove type panel connection system, and is referred to as the Zer-O-Loc Sleeve-Joint panel connection system	Structural	Commercial-cooling facilities, control environmental rooms, cladding	Exterior
37	Folding Dividers	Panel Systems Manufacturing, Inc., USA, WI	Fabric- Hinged wall panels used for interior room separation. Core and skin composed of sound-absorbing material.	Partition - A nonstructural commercial interior hinged wall panel for room separation.	Fabric OR Custom / Other + Frame	Fabric OR Custom / Other	Hinged	Non-structural	Commercial	Interior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
36	EPS Insulated Panels	Standard 46" widths		Wall, floor and ceiling					9757 Juanita Drive N. E. Suite #119 Kirkland, WA 98033 425.823.4588 www.zeroloc.com	Web	Specs available on website
37	Folding Dividers	6'-6" and an 8' height	1-1/8" thick	Interior room separation					Panel Systems Manufacturing INC. 110 Highway 10 Plum City, Wisconsin 54761 www.roomdividers.org	Web	Hinged technology could be used for residential wall panel systems

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
38	Composolite	Strongwell, USA, VA	Fiberglass- A fiberglass panel system consisting of six interlocking components, five of which are used for connecting the panels. There is nothing placed between the interior and exterior of the panel.	Building + Other- The structural panel is used to construct enclosure systems and buildings. The system allows for flexibility of structure shape. The panels are easy to connect because all components slide together.	Fiberglass steel composite	Fiberglass steel composite	3-way and 45° connectors allow the system components to turn corners and facilitate the joining of walls or sides. Toggles lock panels and connectors together securely. For added flexibility, the system also includes a hanger and an end cap.	Structural	Commercial	Exterior
39	Fiberglass Structural Armor	GAFFCO, USA, NY	Fiberglass- A light weight bullet-resistant fiberglass and ballistic steel not insulated panel.	Building + Other- The panel is used in the exterior and interior construction of bullet proof buildings and structures. Sheet-rock and wood veneers can be bonded directly to its front face (the side bullet enters).	Fiberglass	Fiberglass	Panels are screwed together.	Non-structural	Commercial	Exterior + Interior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
38	Composolite	24" wide	3"	Buildings; Bridge enclosure systems; Cooling towers (top-right) Wastewater covers (bottom-right); Bridge decks; Tank covers Platforms & walkways; Cellular enclosures					400 Commonwealth Ave. P. O. Box 580 Bristol, Virginia 24203-0580 USA Phone: 276-645-8000 FAX 276-645-8132 e-mail: webmaster@strongwell.com www.strongwell.com	Thomas Register	Simple but neat.
39	Fiberglass Structural Armor	Varies by project		Bank teller counters; Gas stations; Convenience stores; Pay counters Remote electronic buildings; Secure rooms					6 North Street Mount Vernon, NY 10550 Tel: 914-663-9266 gaffco@bullet-proofing.com www.gaffco.com	Web	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
40	Kalwall	Kalwall, USA, NH	Studs and Skins- Fiberglass Skins/ Aluminum Studs or Frame - Translucent sandwich wall panel formed by permanently bonding, under heat and pressure, a specially formulated fiberglass-reinforced face to the extruded structural aluminum or composite I-beams grid core.	Building - A structural panel used for commercial exterior translucent walls or skylights.	Fiberglass	Metal Frame	Clamp-tite closures at head, sill, jamb and unit-to-unit serve only a sealing function.	Structural	Commercial	Exterior
41	Gas Filled Wall Panels (GFP)	Lawrence Berkeley Lab designed and is currently seeking private industry for manufacturing applications, USA, CA	Gas- A gas filled panel made up of thin polymer film baffle and a bag sheathing, filled with low-conductivity gas. Flexible bags, and structure is given by the baffle (think polymer film that is similar to a honeycomb sandwich panel).	Building + Other	Polymer Film	Gas	Application has not gone that far		Residential + Other	
42	SW-400	Skywall Translucent Systems, USA, TX	Studs and Skins- Fiberglass Skins/ Aluminum Studs or Frame - A glass / clear or translucent double paned panel with a hollow core. Panel is held by thermally broken aluminum frame.	Building - A structural panel used for commercial walls.	Glass + Metal Frame	Hollow	Connectors in which panels slide in. Metal connectors bolted to building - depending on construction design.	Structural	Commercial	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
40	Kalwall			Walls, skylights, window systems			See webpage		1111 Candia Road PO Box 237 Manchester, NH 03105 Phone: 603-627-3861 Email: info@kalwall.com www.kalwall.com	Web	
41	Gas Filled Wall Panels (GFP)			Predicted use-residential wall, appliances, cars, storage and transport					Contact: Rs. Taylor at Technology Transfer. 510-486-5366 Additional information at: http://gfp.lbl.gov or http://eetd.lbl.gov/btp/papers/38093.pdf	Web	Not sure if the technology has gone anywhere.
42	SW-400	8' tall, 5' long, TYP - though can vary	Translucent panel: 2-3/4", Glass panel: depends on glass used.	Walls	Varies with project			International	750 Airport Road Terrell, TX 75160 800-259-7941 www.skywall.com	Web	Can be glazed from inside or outside.

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
43	NANA Wall WA 67	NANA Wall Systems, USA, CA	Studs and Skins- Fiberglass Skins/ Aluminum Studs or Frame - Large glass window-like wall panels that slide open in various ways. Framing material can be made of various metal and wood products.	Building - A nonstructural residential and commercial exterior opening glass-wall system.	Glass + Metal (exterior) + Wood (interior): Exterior: aluminum, extruded with choice of over 200 colors, attached to the core to protect and isolate the wood. Interior: wood	Glass + Wood: Varies - pine, douglas fir, hemlock, oak, or tropical hardwoods	Panels are hinged together and sealed with weather stripping. The panels ride along a top and bottom track; design is based on desired folding pattern of panels.	Non-structural	Residential + Commercial	Exterior
44	Hollow Core Panel	Fintech Precast, Inc., USA, CA	Concrete- Hollow Core Precast - With additional of insulation to the hollow core areas, wall R-value can exceed R-25.	Building - A structural panel system used for commercial exterior walls. If insulated, can be used for refrigeration facilities.	Concrete	Hollow		Structural	Commercial	Exterior / Interior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
43	NANA Wall WA 67	Up to 9' high	approximately 3"	Opening window walls					707 Redwood Highway Mill Valley, CA 94941 (800) 873-5673 www.nanawallsystems.com info@nanawallsystems.com		
44	Hollow Core Panel	Varies by project	Varies by project	Walls					888-837-6522 toll free / 530-241-8397 local 16761 Clear Creek Road, Redding CA 96001 info@fintechprecast.com http://www.fintechprecast.com/Default.htm	Web	FinTech makes another of other panel products as well.

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
45	Honeycomb panels	Bellcomb Technologies Incorporated, USA, MN	Honeycomb- Wood Based, Metal Based, and Plastic Based -A lightweight structural panel made of stiff skins, such as aluminum, steel, hardboard, and fiberglass adhered onto lightweight core materials like honecombs urethoane foams and balsa. The panels are framed with various materials including: aluminum extrusion, roll formed steel and aluminum, solid and formed plastics.	Building- A rigid panel used for high-traffic flooring and vault covers. Panels can be used for other projects, these are the most common uses.	Varies- Aluminum, Steel, Hardboard, Plywood, ABS, Kydex, Polyethylene, Lauan, Paper, Stainless Steel, Plastic Laminate, Fiberglass	Varies- Phenolic honeycomb, Aluminum Honeycomb, Plastic Honeycomb, EPS, Urethane Foam, Balsa Wood. Frame: Aluminum Extrusion, Steel and Aluminum, Plastics, and Wood	Aluminum, wood, steel etc.	Structural	Commercial	Interior
46	Aeronautical Panels	Euro-Composites, International, Germany	Honeycomb- Wood Based, Metal Based, and Plastic Based - A non-metallic, lightweight and extremely rigid sandwich panel formed of ECA Honey comb core with a skin specialized to suit airplane construction. The ECA core has an extremely high strength-to-weight ratios. It is also electrically and thermally insulating, chemically and corrosion as well as shock and fatigue resistant. The ECA-core is easy to form and is self-extinguishing.	Aircraft- The structural panel is used for air plane floors, ceilings, and helicopter blades.	Varies	Honeycomb - ECA	Varies	Structural	Commercial	Interior + Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
45	Honeycomb panels	Up to 13'-6" high, 8' wide and 53' long		Floors, vault cover	More expensive than heavy weight panels				Bellcomb Technologies Incorporated 70 North 22nd Ave. Minneapolis, MN 55411 www.bellcomb.com	Thomas Register	
46	Aeronautical Panels	Width (L) : 48" ±2" Length (W): 96" ±3"	0.12"	Aircraft interiors; Helicopter blades			Meeting FAR and ATS requirements, depending on specs	International	EURO-COMPOSITES® S.A. B.P.24 Zone Industrielle L-6401 Echternach G.D. Luxembourg www.euro-composites.com	Newport Partners research-Mark Nowak 301-889-0017	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
47	Dimensionally Stable CFRP	Sapem, International, Russia	Honeycomb- Metal Based - A sandwich honeycomb panel with skins from epoxy based CFRP (carbon fiber reinforced plastic)	Aeronautics- This structural panel is used to construct satellites and space stations.	Plastic - CFRP	Honeycomb		Structural	Aeronautics	External
48	Honeycomb (also makes SIPs, fire-rated mineral fiber panels, injected foam panels, laminated panels, framed panels, and foam glass panels. Foamglass panels worth looking into.)	Panel Projects, International, UK	Honeycomb- Metal Based and Plastic Based - A structural panel with various facing and core options. Facing options include: steel, coated steel, aluminum, stainless steel, and PVC. Honeycomb core options are: aluminum, polycarbonate, polypropylene, and paper.	Building- The structural panels are used in buildings, boats and ferries, aerospace, and interior paneling.	Varies- Steel, Coated Steel, Aluminum, Stainless Steel, and PVC	Varies- Honeycomb options: Aluminum, Polycarbonate, Polypropylene, and Paper		Structural	Residential + Commercial	Interior + Exterior
49	In-Sulate Ex-Sulate	AGILE Building Systems, USA, PA	SIP- Plywood/OSB/ Gypsum/Foam Core - In-Sulate - Laminated panels made of gypsum board and rigid polyisocyanurate foam insulation. Ex-Sulate - Laminated urethane foam and exterior cement-bonded particle board. These products reduce thermal bridging through framing in addition to generally adding insulating value and a moisture barrier.	Building - A nonstructural residential interior- or exterior-surface insulation and moisture barrier system, applied to the existing wall.	Gypsum (In-Sulate) OR Cement Bonded Particle Board (Ex-Sulate): These materials are only the skin on the exposed side of the panel system.	Insulation - Polyisocyanurate OR Urethane	Mechanical fasteners and adhesive.	Non-structural	Residential + Commercial	Interior (In-Sulate) OR Exterior (Ex-Sulate)

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
47	Dimensionally Stable CFRP			Satellites and space stations					Russia www.advtech.ru/english	Web	
48	Honeycomb (also makes SIPs, fire-rated mineral fiber panels, injected foam panels, laminated panels, framed panels, and foam glass panels. Foamglass panels worth looking into.)	Varies	Varies	Buildings, boats and ferries, aerospace, and interior paneling.					Portview Road Avonmouth Bristol BS11 9LQ United Kingdom E-mail: sales@panelprojects.com Telephone: +44 (0)117 316 7020 www.panelprojects.com	Web	Make various types of panels, see website for more info, www.panelprojects.com
49	In-Sulate Ex-Sulate	In-Sulate- 4' X 8' to 4' X 16' Ex-Sulate- 4' X 8' to 4' X 10'	In-Sulate - ? Ex-Sulate- 1" to 4" foam	Walls			ASTM E-84, ASTM C 273, ASTM D 1623 ASTM C 518, ASTM D 1621. Approved by any and all codes that apply, BOCA		3500 West Fourth Street Williamsport, PA 17701-0126 717-326-5640 www.agilebuildingsystems.com agilesys@earthlink.net emailed for info 11/18	Bill Zoeller	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
50	StormRoom	DuPont, USA	SIP- Plastic - The high strength panels constructed with a skin of Kevlar, a material typically used for cold storage appliances, and are insulated with Styrofoam and plywood.	Building - A structural residential wall and enclosure system to protect against impact from flying objects in a tornado.	Kevlar	Styrofoam + Plywood	Steel connecting system. Panels must sit on a concrete floor and be anchored down.	Structural	Residential	Interior
51	Versa-King, Pivot-Lock	Warehouse Equipment and Supply Company, USA, AL	SIP- Plastic - An insulated laminated wall panel with a solid polystyrene core for R-13 insulation rating and superior sound attenuation.	Building - A structural industrial panel wall system used for the construction of interior modular storage buildings.	Vinyl + Laminated Wood Fiber Board	Polystyrene	Versa-King - screwed together Pivot-Lock - pivot and lock together.	Structural	Industrial	Interior
52	High Performance Sandwich Panels	Diab, USA,TX	SIP- Plywood/OSB/ Gypsum/Foam Core - Lightweight sandwich panels comprised of various skins and core materials. Skins include three-ply Okume plywood, 1205 e-glass/polyester, 8-10 oz. e-glass, and fabric epoxy prepreg. Core materials include dinidyell or probalsa.	Furniture + Recreational- This high-strength panel is used for the construction of furniture, bulkheads and cabin structures.	Variety- Three-ply Okume Plywood, 1205 e-glass / polyester, 8-10 oz. E-glass, fabric epoxy	Variety-Cored with either Divinycell (foam) or ProBalsa.			Commercial	Exterior + Interior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
50	StormRoom	4' X 6' to 8' X 8'	7"	Tornado shelter enclosure system, including 4 walls and a roof.	\$4,000 to \$8,000 for completed room			Manufactured in Texas and Oklahoma	Spoke with a DuPont Representative	Builder Magazine, February 2003	Door must meet CEMA 320 size requirements to meet its criteria for use as a tornado shelter.
51	Versa-King, Pivot-Lock	Pivot-Lock-typically 8' X 12'. Versa-King- ?	Typically 3"	Interior modular building or storage area.					Regional Sales Office Montgomery, AL 36106 Phone 800-239-3434 www.warehouseequipment.com (205) 942-1900 sales@warehouseequipment.com		Versa-King has built in wiring chase every four feet and snap on wiring covers. Both systems allow for easy replacement of panels.
52	High Performance Sandwich Panels			Furniture, decks, bulkheads, cabin structures, etc.			ASTM tested	International	315, Seahawk Drive, DESOTO, Texas 75115154 Tel (972) 228-7600 info@diabgroup.com http://www.diabgroup.com	Thomas Register	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
53	Full Width Masonry	Advanced Masonry Technology, Inc., USA, OH	Masonry - The panel system is full width masonry - a wall of bricks reinforced with horizontal and vertical steel. The prefabricated brick wall had epoxy-coated steel running horizontally and vertically throughout. Some wall systems have galvanized studded steel backing and foil faced mineral wool insulation, creating an effective air barrier.	Building - A structural commercial exterior wall system.	Masonry	Masonry + Metal: Steel running horizontally and vertically throughout the wall system.	Panel to panel -soft joint connections, designed for individual jobs. Gravity frame connections every thirteen feet.	Structural	Commercial	Exterior
54	Composite Wall	Kessel Construction, USA, PA	SIP- Steel/Metal Sheet/Foam Core - A composite sandwich panel with Celotex rigid insulation and metal skin. This is a liner panel system.	Building - A nonstructural commercial and industrial interior wall system.	Metal	Celotex, rigid		Non-structural	Commercial + Industrial	Interior
55	ReZist-It Building Systems	GloPac, USA, CA	SIP- Steel/Metal Sheet/Foam Core - A metal framed, cement board exterior panel encapsulating urethane insulating core.	Building - This structural panel is used to construct residential and commercial walls.	Cement Board + Meta, cement slurry is poured into a G-60 galvanized steel frame	Urethane	Top and bottom steel strut. Steel rod locked down with a unistrut.	Structural	Residential / Commercial	Interior / Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
53	Full Width Masonry	2-3 story projects	Varies with brick manufacturer	Walls				Most cost effective within 600 mile radius	PO Box 878 Brunswick, OH 44212 330-225-9496	Steven Winter	Good product for LEED projects. Can easily integrate with other panel systems
54	Composite Wall			Walls					Bradford, PA. - Phone: (814) 362-4696 www.kesselconst.com	Web	
55	ReZist-It Building Systems	Up to 4' wide to 24' high	2 2/4" and 4 1/2"	Walls	Varies by project			International	Frank and Susanna MacDonald 925-254-6619 glopac1@comcast.net	Automated Builder, August 2003	Component manufacturer-uses various panel systems in projects. Just created a joint venture with various system manufacturers to supply the best affordable housing in CA.

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
56	APT-O-Lite	APT Industries Inc., USA, NC	SIP- Aluminum Cladding/Foam Core Aluminum sandwich panel with an 2 1/2 lb. density U.L. Class I polyisocyanurate core. The connecting systems creates a tight seal between panels.	Ducts - The structural panels are used to construct insulating rooms around ducts.	Metal - Aluminum	Polyisocyanurate, 2 1/2 lb. density U.L. Class I	Panels are joined by no-thru metal extruded aluminum structural members. All panel joints are sealed air and watertight with a specially formulated silicone sealer and will be mechanically fastened with drill point screws or pop rivets.	Structural	Industrial	Interior
57	Panel Wall Enclosures	Industrial Noise Control, USA, IL	Steel- With Ribs - The metal acoustical panel system with interchangeable panels is made of 18 gauge solid steel outer skin and welded to an 18 gauge channel frame and a core of 22 gauge perforated inner skin.	Building- The structural panel is used for exterior walls of commercial and industrial facilities such as interior office, control pits, and shelters.	Steel	Steel	H-jointer, basically a sheet I-beam connection with top and bottom tracks	Structural	Commercial + Industrial	Interior
58	Provide Dri-Design®	Exterior Technologies Group, Inc., USA, MI	Metal- The solid panels are made of various types of metal. The panel is a dry joint, rain screen, pressure equalized wall panel system.	Building - A nonstructural commercial wall surface, rain screen system.	Metal, Varies: aluminum, rheinzink, copper, stainless steel, embossed stainless, painted aluminum	Metal, Varies: aluminum, rheinzink, copper, stainless steel, embossed stainless, painted aluminum	Panels have a dry joint design with an integral interlocking gutter. Panels interlock and over lap to create a rain-tight connection. Corners are to be welded.	Non-structural	Commercial	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
56	APT-O-Lite		Approximately 2.5"	Duct insulation					P.O. Box 7486 Charlotte, NC 28241 (704) 598-9100 sales@aptair.com www.aptair.com	Thomas Register	2" thickness of acoustical fiber enclosed in a perforated aluminum liner for sound dampening
57	Panel Wall Enclosures			Noise control, Personnel shelters Control pulpits Soundproof walls Shop offices Test cells Machine enclosures					401 Airport Road • North Aurora, Illinois 60542 Phone: (800) 954-1998 sales@industrialnoisecontrol.com www.industrialnoisecontrol.com emailed for info on turnkey assembly 12/11. Called gave me info	Thomas Register	
58	Provide Dri-Design®	10' wide and 24"high	.063" for panel dimensions from 30" - 36" and .080" for panel dimensions 36"-48". Overall depth of panels to be 1-¼".	Walls			Air ASTM E283 - passed 6.24 psf Water ASTM E331 - passed 15.00 psf Structural ASTM E330 - passed 65 psf		P.O. Box 264 Zeeland, MI 49464 Call Direct: (616) 355-2970 E-mail: Sales@Dri-Design.com www.dri-design.com	Web	Patents pending.

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
59	Deltec	Deltec Homes, USA, NC	Studs and Skins- Wood Studs/ Wood or Drywall Skins -Open wall system with optional 1" foam board insulation or fiberglass batting. 2x4 or 2x6 wall construction with double 2x10 headers on all wall panels. Skin is spruce or Southern Yellow Pine wood with optional foam board or fiberglass batting.	Building- Structural panel used for residential exterior walls.	Wood	Optional Foam Board or Fiberglass Batts and wood framing	Panels connected using a strapping system that is nailed down.	Structural	Residential	External
60	Forest Homes	Forest Homes, USA, PA	Studs and Skins- Wood Studs/ Wood or Drywall Skins -Open wall system with OSB sheathing and 2 X 4 framing. Each panel is equipped with insulated windows and predrilled for electrical wiring.	Building- Structural panel system used for residential exterior and interior walls.	OSB	Wood- 2 X 4 framing	Panels are nailed together. Panels span floor joists and are nailed down. Mechanical fasteners are used to strap panels on-varies regionally, built to code	Structural	Residential	Exterior + Interior
61	Environmental Enclosure	National Partitions, USA, FL	Panels are seamless in height and are 3-ply sandwich construction. Facings of 26 gauge G90 hot-dip galvanized steel with smooth white finish. They are pre-painted with baked acrylic enamel and have a thermal insulated core of polystyrene or optional isocyanurate for energy efficiency up to R-44.	Building- Structural panel system used for rooms that need precise temperature, humidity and contamination control.	Steel	Polystyrene or optional isocyanurate	Bolted to connecting posts. Fasteners are concealed and panels are easily removed.	Structural	Commercial	Interior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
59	Deltec	Width of 8' Height of 8', 9' 10'	6 5/8" or 8 5/9"	Wall	30-35\$/ sq ft			International	604 College Street Asheville, NC 28801 800-642-2508 Spoke with a project Mgr. 11/17 www.deltechomes.com	NAHB Building Systems Council	Polygonal shape. Although the walls are load bearing, they do not bare a load because the roof is self supporting.
60	Forest Homes	Varies by project	4-9/16" with drywall	Wall	Varies with project		Built to regional code	Northeast and Mid Atlantic	RR 1, Box 131k Route 522 Selinsgrove, PA 17870 Phone: 800-872-1492 Fax: 570-374-6093	Alex Grinnell	
61	Environmental Enclosure	40' high	3"-6"	Environmenta l enclosures					305.822.3721 • 340 W. 78th Rd Hialeah, FL 33014 www.n-p.com	Thomas Register	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
62	DuFLEX	Thai-Kiwi Marine Company Limited, International, Thailand	Honeycomb- Wood Based Panels made of high-fiber fraction composite materials laminated with a high performance epoxy resin reinforced with multiaxial E-glass or carbon fiber, and peel-plied. The core is a phenolic impregnated paper honeycomb. The skin is a rigid end grain balsa w/ structural linear or cross linked foam.	Boat- The structural panel is used to construct recreation boats, walls and floor.	Wood, a rigid balsa + Foam	Honeycomb, phenolic impregnated paper honeycomb	Z-Joint on both edges; a Z-Press is used to adhere the panels	Structural	Recreational	External
63	PolyCore- FRP	Contemporary Storage Systems, USA, NY	Plastic- A high impact polypropylene copolymer substrate panel. The panel is a corrugated/fluted core panels made of FRP (fiber reinforced plastic) board.	Building - A nonstructural commercial, industrial, institutional and agricultural interior wall system.	FRP + Plus, finish as desired.	FRP		Non-structural	Commercial + Industrial + Agricultural	Interior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
62	DuFLEX	Standard size- 4' x 8'		Boats					phone [6636] 231023 2/21 Soi 7, Phaholyothin Road, Saraburi 18000, Thailand boat@thaiboating.com www.thaiboating.com	Web	
63	PolyCore- FRP	Width: 3', 4' & 5' Lengths: 5', 6', 8', 9', 10' & 12'		Interior walls and ceilings of institutional, agricultural, commercial and industrial buildings where sanitation, durability, aesthetics and safety are critical.					PO Box 29- 892 Route 11 Kirkwood, NY 13795 888-673-8540 info@cssystems.us www.cssystems.us	Web	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
64	Prestowall Design	Affordable Building Systems, USA, Texas	Straw -Prestowall panels are long fibrous soft red or white wheat straw extruded with heat and pressure to create a high-density, durable, and fire-resistant product. The natural resins of the wheat create an extremely strong panel that can withstand a heavy impact.	Building- The nonstructural panel is used in replacement of drywall. Reduces the need for additional studs with steel frame construction.	Paper - Recycled	Straw	Nailed down to bottom plate and connected together with connection disks and adhesives	NonStructural	Unspecified	Interior
65	R-Control	R-Control Building Systems- licensed to local manufacturers, USA, International	SIP- Plywood/OSB/ Gypsum/Foam Core - A strong structural system consisting of Perform Guard Expanded Polystyrene (EPS) insulation laminated to oriented strand board (OSB) forming a structural panel. The EPS is coated with a termite resistant product.	Building- A structural systems used for walls, roofs, and floors in all types	OSB	EPS- Perform Guard Expanded, termite resistant	Diamond snap-tie connectors	Structural	Residential + Commercial	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
64	Prestowall Design	Varies by project	2-1/4"	Walls			ASTM tested for various specs		2750 State Hwy 160 S Whitewright, Texas 75491 Toll Free 866.364.1198 www.affordablebuildingsystems.com	Web	
65	R-Control	4' X 8' to 8' X 24'	4.5", 6.5", 8.25", 10.25", 12.25"	Residential and commercial walls, roofs, and floors including office buildings, schools, churches, apartments, strip malls, and community buildings.	Varies by region	No CFCs, HCFCs, HFCs or formaldehyde . Energy Star Partner	See print out for details	USA, Japan, UK	Local Manufacturer Branch River Foam Plastics 15 Thurber Blvd. Smithfield, RI, USA, 02917 800-336-3626 emailed for info, 11/5	Web	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
66	Insulspan	Insulspan, USA, ID	SIP- Plywood/OSB/ Gypsum/Foam Core - Panel are made of an Expanded Polystyrene (EPS) core bonded between two outer layers of rugged Oriented Strand Board (OSB). Contains one pound of Expanded Polystyrene (EPS) for every cubic foot of core.	Building- The panel is suitable for many residential and commercial building applications. They are solid, one-piece structural components that can be used in walls, floors and roofs.	OSB	EPS- one Lb for every cubic foot of core	Nailed together. The use of USP structural connectors are recommended. See binder.	Structural	Residential + Commercial	Exterior
67	Murus	Murus, USA, PA	SIP- Plywood/OSB/ Gypsum/Foam Core - Panels available as polyurethane (PUR) panel with unique tongue and groove edge profile and patented cam-lock connectors. Also available is the Expanded Polystyrene (EPS) panel. Both panel types are available in various thicknesses, lengths and skin configurations. Both panels are sheathed with OSB.	Building- Structural panel used for residential and commercial exterior wall, roof, and floors.	OSB	Varies- PUR or EPS	PUR- Cam-locking Connector works with the tongue and groove edge profile. Once one or two locks are engaged, the panel is supported correctly in place and is ready to be secured to the framing members.	Structural	Residential + Commercial	Exterior
68	Agriboard	Agriboard, engineered by Raytheon Engineers and Constructors, USA, TX	Straw -A panel system with a core made of compressed agricultural fibers (wheat, rice, straw) and an OSB skin. The fiber board incorporates a natural mineral to resist termites, carpenter ants and other pests. The board provides up to a 2-hour fire resistance.	Building- Structural panel used for residential exterior and interior walls, floors, and roofs. Panels are also used in commercial construction	OSB	Agrifibers- wheat, rice, straw	Nail (* see print out for more)	Structural	Residential + Commercial + Industrial	Exterior + Interior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
66	Insulspan	4' X 8' to 8' X 24'	3.5" or 5.5"	Walls, roofs, and floors.		No CFC's use in production. Free from volatile formaldehyde	National Evaluation Report # NER-520. See binder.	Also sold in Japan due to earthquakes.	www.insulspan.com	Web and SWA	The strength of this adhesive makes these panels structurally analogous to an I-beam. Nailable
67	Murus	PUR- 4' X 4', 6', 8', 9', 10', 12', 14', 16',18', 20'. EPS- 4' X 8', 9', 10', 12', 14', 16',18', 20', 24'	PUR-4-1/2", 5-1/2" & 6-1/2". EPS-4-1/2", 6-1/2", 8-1/4", 10-1/4" and 12-1/8"	Walls, roofs and floors				International	Email: murus@epix.net PO Box 220 Rt. 549 Mansfield, PA 16933 570-549-2100 www.murus.com Spoke with Chris Bloom, Sales Rep. 11/11.	Web	Molded Tongue and Groove Edge Profile assures quick, proper alignment of panel-to-panel joints. - FIND NOTES AND PRINT OUTS
68	Agriboard	up to 9' long and 24' wide	4-3/8" to 7-7/8"	Walls, roofs, and floors.	\$5.50 to \$8/ft2	All natural insulation, and non-toxic and non-corrosive.	* see print out regarding certifications		P.O Box 151 Bectra, TX 76360 940-495-3590 www.agriboard.com fcoble@agriboard.com. Sent email 11/11	Automated Builder, November 2002	Primarily Residential

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
69	ThermaSteel	ThermaSteel, USA, VA	SIP- Steel/Metal Sheet/Foam Core - A panel with a core of EPS and framed with 24-gauge, G-90 galvanizing steel, typically finished on interior with appropriate gypsum composite although any type of cladding may be field applied to the interior and exterior sides of the panel similar to traditional construction methods.	Building - Used for structural residential and commercial interior or exterior wall systems.	Metal + EPS, Structural grade double steel frame, and EPS core is exposed over major area of panel.	EPS + Metal Studs, Steel "C" studs, thermally broken, @ 16"o.c.	Shiplap joints and self-tapping tech screws. Preferred method: metal tracks for top and bottom plate.	Structural	Residential + Commercial + Industrial	Interior / Exterior
70	Structure Wall, Wood Clad	Winterpanel, USA, VT	SIP- Plywood/OSB/ Gypsum/Foam Core - Comprise of 7/16" OSB, 3-11/16" polyisocyanurate, a minimum 2-lb/ft ³ density, Class I, closed-cell foam. The foam insulation contains no formaldehyde or formaldehyde-related chemicals.	Building- A structural panel used for the construction of interior and exterior residential wall construction.	OBS, 7/16"	Isocyanurate, 3-11/16" + Polyisocyanurate, a minimum 2-lb/ft ³ density	Spline, nail and expanding foam sealant	Structural	Residential	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
69	ThermaSteel	4' X 8', 10', 12'	3.5', 5.5', 7.5'	Panels made for foundations, floors, walls, roofs and ceilings	Quoted based on architectural spec's for specific project	Energy Star, 100% recyclable steel and EPS	ICC-ES, ICBO, BOCA, SBCCI, and HUD.	International	609 West Rock Road, Radford, VA 24141 USA Phone: 1-540-633-5000 Fax: 1-540-731-3712 www.thermasteelcorp.com	Web	
70	Structure Wall, Wood Clad	48" X 8, 9, 10, 12, 14, 16, 18, 20, 22, 24	4-9/16", 5-9/16", 6-9/16"	Residential, light commercial					WINTER PANEL CORP. 74 Glen Orne Drive, Brattleboro, VT 05301 (802) 254-3435 • Fax: (802) 254-4999 sales@winterpanel.com	Jackie Lampiasi, Davis Frames	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
71	Pacemaker Plastics Co., Inc	Pacemaker Plastics Co., Inc, USA, OH and PA	SIP- Comprised of APA rated OSB facers adhesively bonded to UL certified expanded polystyrene (EPS) insulation cores. (R-16) to 12 9/16" (R-45) to meet insulation and structural requirements.	Building- A structural panel system used for exterior walls and floors in all building types.	OSB-APA rated	EPS- UL certified	Nail base-Long screws	Structural	Residential + Commercial	Exterior
72	Korwall	Korwall, USA, TX	SIP- Korwall Foam Core Panels are structural building components made with two layers of wafer board laminated under pressure to a core of expanded polystyrene (foam).	Building- A structural panel system used for the construction of residential exterior walls, roofs, and floors. Widely used across the US.	OSB- wafer board	EPS	Lumber spline	Structural	Residential + Commercial	Interior (?) + Exterior
73	Norse Building Systems	Norse Building Systems, USA, WI	SIP- Panels are constructed with 7/16" OSB exterior sheathing glued and nailed with fiberglass insulation – R-19. Walls are framed with 2 X 6 – 16" o.c. and have 2 X 6 – bottom plate and double top plate. All panels have an infiltration barrier house wrap (Tyvek). Where available, panels come with siding installed.	Building- Structural panel system used for residential exterior walls.	OSB and GWB Interior	Insulation - Fiberglass + Vapor Barrier		Structural	Residential	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
71	Pacemaker Plastics Co., Inc	4' X 8' to 8' X 28'	4 9/16" to 12 9/16"	Used as roofs, exterior walls, and floors in virtually all building types- religious, fast food, educational, residential, and light commercial	\$3 per sq. ft. for a 4-1/2" panel and typically add \$.40 for each step up in thickness.		NER and Comprehensive Testing Program reports available on line		emailed for info, 11/5 126 New Pace Road P.O. Box 279 Newcomerstown, OH 43832-0279 Ph: 1-800-446-2188 info@pacemaker.com	Web	
72	Korwall	Up to 8' X 24'	4", 6", 8", 10", 12"	Floor, wall, and roof				National and International	326 N. Bowen Road Arlington, TX 76012 (817) 277-6741 FAX: (817) 277-6743 www.korwall.com	Automated Builder, February 2002	
73	Norse Building Systems	8' height		Wall				Minnesota, Wisconsin, and Upper Midwest	1100 Barnett Rd. Ladysmith, WI 54848 715-532-0600 sales@norsehomes.com ,pmyers@myersgroup.net et emailed for info11/17 www.norsehomes.com	NAHB Building Systems Council	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
74	Better Building Products	W.A. Brown, USA	SIP- Panels are manufactured in a solid frame fixture allowing the inclusion of structural metal members, molded in splines, and the Cam-Lock closure, and the exterior skins. The panels are injected under pressure with a two part urethane foam that expands and fills the core, bonding to the exterior skins. Skins can be various products including OSB and metal	Building- The structural panel is used for exterior residential walls and industrial storage facilities.	Varies- OSB, Metal	Polyurethane	Cam-lock	Structural	Residential + Industrial	Exterior
75	SIP Insul-Lam	Premier Building Systems, USA, WA	SIP- Panels consist of an EPS core laminated between two sheets of engineered wood. These panels are simple to install. Featured on Bob Vila and Habitat for Humanity, PBS panels are the next generation of engineered building systems.	Building- Structural panels used in floors, walls and roofs from high end residential (log homes, timber frames and custom homes) to affordable housing and commercial construction (schools, hospitals, retirement centers) as well as multi-family units. The Premier Panels used in conjunction with other engineered systems and engineered building products.	OSB	EPS	Panels are screwed together with long screws.	Structural or Nonstructural	Residential + Commercial	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
74	Better Building Products	9' X up to 16'	4.5"	Walls / freezers / storage structures	Varies with project	Energy Star Partner		National	Reid Brodie 704-636-5131 rbrodie@wabrown.com Sending information on Monday 11/17	ICC-ES	
75	SIP Insul-Lam	4' X 8' up to 8' X 24'	4", 6", and 8"	Walls	4" thick = \$3.12 6" thick = \$3.40 8" thick = \$3.75 10" thick = \$4.00 12" thick = \$4.40		Carry code reports from national and international model building authorities	International	Northwest Region 4609 70th Ave. E Fife, WA 98424 800-275-7086 fife@pbspanel.com Spoke with on 11/14	ICC-ES	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
76	Panels-Plus Post and Beam	Normerica, International, Canada	SIP- Panels-Plus- Panels are 2 X 6" site assembled pre-engineered walls with 7/16" OSB, batt insulation, Tyvek building paper, 1 X 3 strapping and 6mil poly vapor barrier supplied for site insulation Post and Beam- Panels are 2 x 4's with 7/16" OSB, 1-1/2" of EPS insulation, batt insulation, 1x 4 strapping and 6mil poly vapor barrier supplied for site installation.	Building- Panels-Plus are a structural panel used in the construction of residential exterior walls. Post and beam are a non-structural panel used in the construction of residential exterior walls. Panels are connected to large structure supporting beams.	OSB	Wood + Batt or EPS. Panels-Plus- 2 X 6" framing. Post and Beam- 2 X 4" framing.		Structural (Panels Plus) or Nonstructural (Post and Beam)	Residential + Commercial	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
76	Panels-Plus Post and Beam	Varies by project	Approximately Panels-Plus- 8" Post and Beam- 6"	Residential wall and roof, commercial wall					150 Ram Forest Road Gormley, Ontario Canada L0H 1G0 905-841-3161 Canada & U.S. 1-800-361-7449 or send us e-mail at info@normerica.com. Emailed for info 11/17, email was forwarded to sales rep. 11/18	NAHB Building Systems Council	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
77	Snap-N-Lock System	Structural Building Systems, USA, FL, LA, and TX	SIP- Steel/Metal Sheet/Foam Core - The panel is made of expanded polystyrene (EPS) foam insulation sandwiched between two structural skins of steel. Skin options include: custom laminated from white or ivory .024 or .032 stucco embossed aluminum coil 3105-H-194, .024 cedar wood grain embossed aluminum coil 3105-H-194, .032 smooth aluminum coil 3105-H-14 or .26 gauge smooth or stucco embossed coated galvanized steel composite. The unique feature of this system is the Snap-N-Lock system used to snap panels together.	Building- Structural system currently used to construct the exterior walls of residential and commercial buildings.	Metal-Aluminum, laminated.024 or .032 stucco embossed 3105-H-194, .024 cedar wood grain embossed, coil 3105-H-194, .032 coil 3105-H-14 or .26 gauge, or stucco embossed galvanized steel .	EPS	Snap-n-Lock system with sealant	Structural	Residential + Commercial	Exterior
78	ICS	Insulated Component System, USA, NC	SIP- The structural panel is composed of a variety of skin materials including OSB, fiber cement, fiber reinforced plastic, plywood, or metal. The panels are insulated with two-part polyurethane class 1 foam. Door and window openings can be pre-engineered into a panel or as a factory option. Panels are framed with 2 X 4 and 2 X 6 wood framing.	Building- The structural panel is used for residential, commercial, and industrial external walls. What is interesting about this systems is that the panels are constructed in varying angles. There is a 90deg and 130deg panel available for the various corners and building shapes.	Varies- OSB, Fiber Cement, Fiber Reinforced Plastic, Plywood, or Metal	Two-part Polyurethane Class 1 foam, and 2 X 4 and 2 X 6 wood framing.	Cam-Lock-Double spline on each side that fits into the adjacent panel	Structural	Residential +Commercial + Industrial	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
77	Snap-N-Lock System	up to 32' in length	2"-8"	Walls			ASTM-1929, ASTM-119, ASTM-E84-95, ASTM-A527 #G-90		350 Burbank Road Oldsmar, FL 34677 800-969-3706 www.structall.com	Web	
78	ICS	Maximum width 4'. Maximum height 16'	3", 4-1/2", and 6-1/2"	Walls, schools, storage homes		Energy Star Rated (Panels are not rated, they can only be ES partners)			323 Farmington Road Mocksville, NC 27028 (336) 940-2575 • Fax: (336) 940-2508 info@ics-sips.com www.ics-sips.com	Automated Builder, February 2003, pg 14	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
79	FISCHERSIP®	FischerSIPS, Inc., USA, KT	SIP- Two sheets of oriented strand board (OSB), with expanded polystyrene foam laminated between them. The panel gets its strength because the OSB and foam act together as a structural I beam.	Building- A structural panel system used for the construction of exterior residential building walls.	OSB	EPS foam	Panel Screws Panel Caulk Expanding Foam Sealant	Structural	Residential	Exterior
80	Sol	Univision S.A., International, Greece	SIP- Steel/Metal Sheet/Foam Core -Sol is a light weight Sol is a composite insulated panel made from two skins of coated, galvanized steel with a core of polyurethane insulation. Panels are designed to span between main steel column externally or from floor to ceiling when used for internal partition walls. They are manufactured according to international standards.	Building- Structural system currently used for the exterior walls of storage facilities for animals, boats, food etc.	Metal - Steel, two skins of coated, galvanized steel	Polyurethane		Structural + Non-structural	Commercial + Agricultural + Recreational	Exterior + Interior
81	Thermal Panel	Eagle Panels, USA, OH	SIP- Mineral Fiber - A steel insulated closed wall panels. Two sheets of either galvanized or aluminized carbon steel and stainless steel surround an insulating mineral fiber. The panel is supported with vertical steel channels.	Refrigeration- The structural panels are used for the construction of refrigeration and heating units.	Steel, Galvanized or Aluminum Carbon Steel and Stainless Steel	Mineral Fiber	Tongue and Groove. Also featuring "ThermalTrak" perimeter channel design for superior heat transfer reduction.	Structural	Industrial	Interior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
79	FISCHERSIP®	4' x 8' up to 4' x 16'		Wall					1843 Northwestern Parkway - Louisville, Kentucky 40203 Phone: (800) 792-SIPS (7477) Fax: (502) 778-0508 E-Mail: sales@fischersips.com emailed for info 11/17	NAHB Building Systems Council	"wood, drywall and nail base"
80	Sol			Storage areas, barns, boat storage, arenas, swimming pools.		Use "environmentally friendly technology"			93 El.Venizelos Str., Chania, Crete, 731 32, GREECE. Tel: (0821) 69-368, 54-825. Fax: (0821) 52-416. http://www.angelfire.com/biz/steelframe/panels.html or http://www.angelfire.com/biz/steelframe/	Web	
81	Thermal Panel	Varies by project	2"-10"	Industrial cold or hot storage.					2500 Brookpark Road, Cleveland, OH 44134 800.988.0632 info@eaglepanels.com www.eaglepanels.com	Thomas Register	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
82	Hurricane Resistant Textured Wall Panels	Structural Northwest, USA, ID	Steel- A layered panel with a textured elastomeric interior finish, cement board layer, insulation layer, and a steel exterior wall panel.	Building - A nonstructural commercial exterior wall system.	Steel + Elastomeric interior finish	Cement Board + Insulation	Drilled to framing.	Non-structural	Commercial	Exterior
83	Modutherm	Dynabilt, USA, FL	Steel- A panel composed of a polymeric insulated core and galvanized steel skin.	Building - A structural residential interior and exterior wall system.	Steel, galvanized.	Insulation, polymeric		Structural	Residential	Exterior
84	Energy Lok (Also make SIPs)	Energy Panel Systems is a division of the MacArthur Company, USA, IA	Steel- A panel constructed of EPS sandwiched between G90 galvanized steel, with 20 year siliconized polyester paint system.	Building - A structural commercial and industrial exterior wall system.	Steel , G90 galvanized - with 20 year siliconized polyester paint system.	EPS	Tongue and groove	Structural	Commercial + Industrial	Exterior
85	Tempcon	Zamil Steel, International, Saudi Arabia	SIP- Steel/Metal Sheet/Foam Core - A sandwich steel wall panel with injected polyurethane. The rigid foam core has a density of 40 kg/m3.	Building - A nonstructural commercial exterior wall system.	Steel, pre-painted	Polyurethane, Foamed-in-place	"Self drilling" fasteners.	Non-structural	Commercial	Exterior
86	Econ/O/Cold	Refrigerator Manufacturing Inc. (RMI), USA, CA	Steel- A steel skins, foamed in place prefabricated panel.	Building - A structural industrial interior refrigeration wall panel system.	Metal, Varies: aluminum, stainless steel or galvanized steel sheet surface, fully adhered to core.	Urethane: Foamed in place	Cam-action-locks	Structural	Industrial	Interior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
82	Hurricane Resistant Textured Wall Panels	40' long, 18'-20' wide	1.5"	Walls					PO Box 592 Boise, ID 83701 208-280-1840	Web	
83	Modutherm			Walls		Energy Star partner				SWA	
84	Energy Lok (Also make SIPs)	46" wide by up to 55' long		Walls					Graettinger, IA 51342 Phone 800-967-2130 www.epsbuildings.com	Rural Builder Magazine, Scott Tapa	SIPs are for residential.
85	Tempcon	Varies by project	65 mm, 80 mm, 105 mm and 130 mm	Walls					www.zamilsteel.com emailed a from from website 11/18 966 (3) 847 1840 PEBMarketing@ZamilSteel.com	Web	
86	Econ/O/Cold	Varies by project	4"-6"	Walk-in refrigeration units.					323-838-5506 7421 Slauson Avenue, Commerce, California, 90040, USA Information: sales@rmi-econocold.com www.rmi-econocold.com	Web	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
87	Acsys Panel System (R-Steel System)	Acsys Inc., USA, ID	Aluminum/Steel- Rib System, Steel- An insulated steel-core wall panel made of 16-20 gauge galvanized corrugated structural core welded to a top and bottom 18 gauge galvanized steel track. A 18 gauge galvanized steel tracks embedded in expanded polystyrene skin using a specialized molding process.	Building - A structural residential and commercial exterior insulating panel wall system.	EPS	EPS + Metal, 16-20 gauge	Panels slide together to mate the "ship-lap" joint with the adjacent panel. Panels are screwed in place using a self-drilling screw at the top bottom and mid section of panel. The product is supplied with the mounting track, fasteners, and corner connectors.	Structural	Residential + Commercial	Exterior
88	Soloflex Wall System	Soloflex Corporation, USA, OR	Steel- Steel Studded wall system, sheathed and unsheathed	Building- Structural panels system. Out of business due to codes. The panel was designed by an exercise equipment company. Panel appears durable.		Steel-steel studs	Nailed	Structural		

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
87	Acsys Panel System (R-Steel System)	2' and 4' food widths and up to 18' long.	6"-12"	Walls			ASTM E455 ASTM 1592 ASTM C578		1677 E Miles Ave. Suite 101 Hayden, ID 83835 (208) 772-6422 Fax: 208-772-5942 acsys@acsys.net www.acsys.net	Web	
88	Soloflex Wall System	Length- 1', 2', 3', 4' Height up to 8'							503-640-8891 Stuart Wilson Phone tag, left message 11/20	Automated Builder, February 2002	Out of business due to codes and trades people. Technology may still be of use.

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
89	LEEP- CORE, & LEEP Free Standing Frameless Building System using LEEP- CORE	LEEP (Leading Earth Edge Products), USA, PA	Steel- The panel is a 2'-wide, structural, lightweight, composite material component that is configured as a highly insulating, load-bearing, structural building panel .The panel is composed of steel skins that sandwich a polyurethane core. LEEPCORE is used to fabricate wall, roof and floor sections for pre-engineered buildings. The systems is fire resistant, water proof, rot, mildew and corrosion resistant, termite proof, and wind and seismic force resistant.	Building - A structural residential and commercial interior and exterior wall, floor and roof panel system.	Steel, polyester coated "galvanized" surfaced.	Polyurethane		Structural	Residential / Commercial	Interior / Exterior
90	Operable Patrician 6000	Hufcor, USA, WI	Steel- The panel is constructed with a steel frame and skin. It is filled with an acoustical substrate. The panel is moveable on tracks.	Partician- This nonstructural panel is used for interior room separation. Often used in conventions centers and areas of high stress. This panel is durable.	Steel	Steel frame, acoustical substrate.	Interlocking vertical seals. A slight turn of a handle activates the locking of the seals	Non-structural	Commercial	Interior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
89	LEEP- CORE, & LEEP Free Standing Frameless Building System using LEEP- CORE	Up to 12' long, 2' wide	4"	Walls, roofs and floors		Non-toxic earth friendly	ICBO ES AC04 and ASTM E72. Reports available on line		Pennsylvania, Info@LEEP inc.com emailed for info, 11/10/03	Web	Panel specs are online in the testing reports
90	Operable Patrician 6000	60' high, width unlimited	4"	Internal wall partitions			Various ASTM testing and registered with ISO		P.O. Box 591 / 2101 Kennedy Road Janesville, Wisconsin 53547; 800-542-2371 Ext. 214 E-Mail- info@hufcor.com www.hufcor.com	Thomas Register	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
91	Stucc on Steel Building System	Stucc on Steel, USA, VA	Steel- The panel is framed with a light gauge galvanized steel and receptor pockets. The internal component is a self setting expanded metal lath, 20-22 gauge. On site the panel is covered with two layers of high-strength structural coating. The coating is a combination of stucco and a new age technology. Thermal reflective foil is used for added insulation, thermal break between siding and metal. Use gasket on studs for thermal break and sound control. This system is currently under patent.	Building- Structural panel used for the exterior wall construction of residential, commercial and industrial buildings.	Steel	Metal, Self-setting expanded metal lath, 20-22 gauge	Screw panels together. Use stud and track to hold panel down on the ground.	Structural	Residential + Commercial + Industrial	Exterior
92	Anchorpanel	Fast Track Foundation Systems, USA, CA	Aluminum/Steel- Rib System, Steel- The panel is made of heavy-duty galvanized and polymer or epoxy coated steel.	Building- The nonstructural panel is currently used as a foundation in residential construction.	Polymer or Epoxy	Steel, galvanized	Interlock at at adjoining edges.	NonStructural	Residential	Exterior
93	Thermotech 21	Techbuilt Systems Inc., USA, OH	SIP- Stud - Thermotech 21™ panels are highly insulated building panels which have a core of EPS supported with exterior and interior steel framing members made from 1" x 2" 18 gauge galvanized steel. Steel framing is 24" o.c.	Building - A structural residential exterior wall and roof system.	EPS + Steel - structural tubing / framing	EPS	The steel framing members are joined together with self-tapping screws to provide a warp-free integral structure. Adjacent panels are joined with top and bottom 1-1/2" x 1-1/2" steel angles which are secured with self-tapping screw.	Structural	Residential	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
91	Stucc on Steel Building System	Varies by project	3-5/8", 6", and 8"	Walls	Varies with project			International	Donald Stevens 540-678-4159 contact@stucconsteel.com Sending info on Monday	ICC-ES	Use thermal reflective foil for added insulation, thermal break between siding and metal. Use gasket on studs for thermal break and sound control. Working on two additional systems, patents in progress--- Information on new system available on CD.
92	Anchorpanel			Foundation and above grade foundation walls					31078 Turner Road, Fort Bragg, CA 95437 800-789-9694 www.fasttrackfoundations.com	Automated Builer, January 2004	
93	Thermotech 21	4' X 4' to 40'	7 1/4"	Walls and roofs			ASTM 119		941 Clark Avenue Cleveland, Ohio 44113 Phone: 216-621-4340 Fax: 216-687-8780 Email: info@techbuilt.com	Rob Aldrich	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
94	Self Storage Panel	Betco Inc., USA, Eastern Half	Steel- Uninsulated solid 22 or 29 gauge steel panels, having no substantial thickness or insulating properties.	Building - A nonstructural commercial exterior wall panel, to attach to wall.	Steel, 22 or 29 gauge	Steel, 22 or 29 gauge		Non-structural	Commercial	Exterior
95	Multi Wall Sheets	Crystalite Incorporated, USA, WA	Structured transparent polycarbonate panel.	Building / Structures - A nonstructural commercial exterior glazing, roofing and cladding system.	Polycarbonate	Polycarbonate	Connected to frame structure with a four sided clamp. All four edges of panel must be clamped.	Non-structural	Commercial	Exterior
96	Open-built	Bensonwood Homes, USA, NH	The open-wall OSB panel has a 16" on-center framing and is insulated with urethane. The panels comes with wired chasing. It is the framing of the home that is load bearing not the panel. This makes it easier to change the skin of the house while keeping the same frame.	Building- This panel is used in the construction of external residential walls.	OSB	Urethane	Horizontal joints- gaskets, vertical joints- gasket and foam	NonStructural	Residential	Exterior
97	Ultratex	Mantex, USA, MI	The panel is made of Ultratex, a polyurethan/polyester formulation. The Ultratex can be used with various skins such as drywall and plywood. Ultratex can also impregnate thin layers of OSB greatly increasing its strength. Ultratex is an insulating, sound barrier, and structural material.	Building-The structural panel is used in the construction of floors walls and roofs of buildings that need extra strength.	Varies- OSB, Plywood, Drywall	Ultratex		Structural	Commercial	Exterior + Interior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
94	Self Storage Panel	Up to 36" wide, cut to any length		Large storage facilities				Eastern half of US.	800-654-7813 www.betcoinc.com	Web	
95	Multi Wall Sheets	Varies by project	1"	Structural ceilings such as bus stops, pavilions, etc.					3307 Cedar Street Everett, WA 98201 (800) 666-6065 www.crystaliteinc.com	Web	
96	Open-built	Customizable, up to 9'-6" X 28'.	4.5"	Walls		Less material wasted			emailed for info, 11/5 reply-already contacted by HUD-11/7	Web	Because each panel is cut and configured with Open-Built flanges first, including all rough openings, only the necessary areas are insulated, eliminating the usual waste.
97	Ultratex	4' X 8' and 5' X 10'	1/4", 3/8", 1/2", 5/8", 3/4", 7/8", 1", 1.5" and 2"	Floor, wall, and roof	More expensive than wood, but only require one layer of material so some cost is absorbed.	Nontoxic		Just starting up	611 Industrial Parkway Imlay City MI, 48444 e-mail sales@mantex.net or call 800-66MANTX	Automated Builder, October 2003	Sound dampening, sizes tailored to job spec, watherproof, fire resistant and/or code rated incombustible, waterproof, mold and mildew proof, light weight, non-toxic, workable as wood, long lasting

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
98	ThermalDRY-used with existing foundation ProTech	T. Clear Corporation, USA, OH	ThermalDRY-A below grade panel made of Styrofoam brand insulation with vertical and horizontal drainage channels that provide a path for moisture to drain. A bonded filter fabric covers the panel to prevent these channels from being blocked. ProTech- An above grade panel insulated with 4" rigid insulation (made by DOW) and covered with 1/4" of Util-A-Crete. Wire chases cut into panels.	Building- Nonstructural ThermalDRY is used in below grade residential wall construction. Pro Tech is used in above grade construction of residential exterior walls.	Varies- ThermalDRY- Bonded fabric ProTech- Util-A- Crete	Styrofoam, made by DOW	ThermalDRY-Tounge-and-groove ProTech-Steel H-connection for panel to panel, steel C-channel for top and bottom. Panels are nailed into steel.	Varies- ThermalDRY- Non-structural ProTech- Structural	Residential	Exterior
99	T-Mass Precast	DOW, USA	Concrete- Sandwich - Using traditional concrete form system Styrofoam insulation is inserted and concrete is poured on either side. Once concrete has cured, remove forms. Concrete held together with composite connectors.	Building - Structural panels used for residential exterior walls.	Concrete	Styrofoam	Varies with project and type of concrete system.	Structural	Residential	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
98	ThermalDRY-used with existing foundation ProTech	ThermalDRY-2' X 8' ProTech-width 3' length 8 1/8', 9 1/8' and 10' (to accommodate internal stick framing)	ThermalDRY-1", 1.5", 2.25" ProTech- 4.5"	Walls				International	2704 NY7 Valley Falls, NY www.tclear.com Brian Gleason Dick Crawford 1800-544-7398 Spoke with him 11/20	ICC-ES, Don Carlson	Has wire ways cut in. HfH projects.
99	T-Mass Precast	Varies by project	T-Mass-concrete 4", insulation 2" Precast-concrete 7", insulation 2"	Walls	Varies by project			National	Frederico Montaner 989-638-6337	Robb Aldrich	SWA is working with T-mass in Wisconsin.

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
100	Versa Wall I Versa Wall II	Pacific Environmental Technologies, Inc., USA, CA	Versa Wall I - The system utilizes easy to configure and install aluminum extrusions to hold the panels in place. The system may be reconfigured, expanded or relocated . Different surface finishes and core options are available. The wall system can be load bearing under certain configurations. Versa Wall II - a structural, steel sandwich modular system for wall and ceiling panels, specifically manufactured for controlled environmental applications.	Building - Both of the systems are used for commercial structural and non-structural wall and ceiling construction. Buildings include environmental and climate controlled facilities.	Varies - Melamine; Vinyl; Fiberglass reinforced plastic ;Aluminum ;Steel ;Stainless steel ;Antistatic coating ;Sheets of 20 gauge metal pre-stiffened by tongue and groove construction.	Varies: - Polystyrene foam; Polystyrene foam w/ 1/2" gypsum wall board on both sides; Paper honeycomb core (fire retardant); Aluminum honeycomb; Insulation - Urethane	Versa Wall I - aluminum extrusions Versa Wall II- joined and sealed by a silastic and fastened together by structurally approved concealed metal screws. Ninety degree (90°) corner sections are used to provide proper alignment and additional strength.	Structural + Non-structural	Commercial	Interior
101	Plywood Doors	Todco, USA, NY	Wood- A wood panel that contains a patented Transportation Core™- a 3/4", 7-ply, premium-grade plywood that forms the foundation of our doors. Panels have a hardwood outer veneer that virtually eliminates wood grain "telegraphing," giving a smoother, more uniform look that lasts.	Transportation- This strong panel is used for cargo truck doors.	Hardwood	Plywood		NonStructural	Commercial	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
100	Versa Wall I Versa Wall II	Vera Wall I - Heights - 8' to 16' Wall heights over 10 ft. typically have a splice joint at 8' or 10' Versa Wall II - up to 20' clear span	Vera Wall I- 2" Versa Wall II- 3", 4", 5 "or 6"	Walls			Vera Wall I- Meets most local building codes for interior partition loads and seismic conditions. Manufactured to meet the various code requirements for flame spread and smoke development. Vera Wall II-report RR-24961		135 Enterprise Court, Corona, California, 92882 Phone: 909.582.9306 - Fax: 909.582.9946 Toll Free Phone: 800.660.9676 Toll Free Fax: 800.581.7942 Inquiries: info@peticleanair.com	Web	
101	Plywood Doors			Truck doors	Affordable				Dave Pettengill 5371 Dutch Hill Rd Hinsdale, New York 14743 Office: 716 557-02091 Emailed from website for info 12/2 <a href="http://www.todco.com/ud
ef_floorsply.cfm">http://www.todco.com/ud ef_floorsply.cfm	Web	Doors are equipped with the TOUGHHELL™ system. The system is a multi-layered formulation of liquid polymers that are specifically designed to work together on wood substrates, and provide a state-of-the-art defense against moisture, abrasion, temperature extremes, harsh chemicals, even UV damage. (Link was down, may want to ask company about this component)

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
102	Harvest Homes	Harvest Homes, Inc, USA, NY	Wood- An open wall system- 2 X 6 studs at 16" o.c., single sole & double top plates, assembled into panels with 7/16" OSB sheathing applied. All door and window units are installed except bay and bow window units, sliding patio doors, and garage service doors.	Building- Structural panel system used in the construction of residential exterior walls.	OSB	Wood- 2 X 6 framing		Structural	Residential	Exterior
103	No name yet, under review for patent	Big Timber Works, USA, MT	Wood- An open wall timber framed wall with the new Open Stud component. Open Stud is a structural wall truss made of small dimension lumber and oriented strand board gussets glued into an I-joist configuration. Will insulate with spray foam upon request	Building- Structural panel will be used for residential external wall construction	Wood - Recycled	Wood- Open Stud framing, spray foam insulation upon request	No panel-to-panel connection because panels come in length of wall. Corners are connected beneath the overlapping siding.	Structural	Residential	Exterior - unknown if interior because patent still under review.
104	Northern Design	Northern Design Building Associates, USA, NY	Wood- Open wall 2 X 6 wood panel, not insulated.	Building- Structural panel system used for residential exterior walls.	OSB or PLYWD	Wood- 2 X 6 framing; open wall system	Entire wall constructed at shop therefore no wall to wall connections. Top and bottom have plates that attach them to floor and ceiling. Corners attached on site with a turn stud	Structural	Residential	Exterior
105	Octastructure	Octa-Structure International Inc., USA, FL	Wood- Open wall wood panel	Building- Structural panel used for the construction of exterior residential and commercial walls.	Wood	Wood framing	Panels are nailed together.	Structural	Residential + Commercial	External

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
102	Harvest Homes		6"	Wall					185 Railroad Ave. Delanson, NY 12053-0189 (518) 895-2341 info@harvesthomes.com emailed for info 11/17 www.harvesthomes.com	NAHB Building Systems Council	
103	No name yet, under review for patent	Up to 49' long and 12' tall	Varies with insulation requests	Wall		Use recycled wood		Local, MT and WY	PO Box 368 Gallatin Gateway, MT 59730 406-763-4639 www.bigtimberworks.com btooffice@bigtimberworks.com Spoke with Merle Adams	Nancy Wilkins, Timber Frame Business Council	Use recycled wood, technology pending patent.
104	Northern Design	Varies by project	3/4" OSB	Walls	Varies by project			Northeast, Mid-Atlantic, International	PO Box 47 Hudson Falls, NY 12839 800-576-0557 Spoke with Rep 11/20	Building Systems Magazine, 9-10/03	
105	Octastructure	Varies by project		Walls				International	1-800-448-4062 2516 West 23rd St Panama City, FL 32405 www.octastructure.com	NAHB Building Systems Council	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
106	American Standard Building System	American Standard Building System, USA	Wood- Open wall wood panel with double top plates and single bottom plates. The skin and construction is intermediate density fiberboard. 2x4 studs 16" on center framing constructed with spruce-pine-fir stud grade kiln dried.	Building- Structural panel used for the construction of exterior and interior residential walls.	Wood- MDF	Wood- 2 X 4 studs		Structural	Residential	External
107	Sliding and Folding Wood Doors	Hafele, International, USA, Canada, and Mexico	Wood- Sliding wood panels.	Partician- This nonstructural panel is used for interior and exterior movable walls. Used in commercial applications.	Wood	Wood	Steel guide tracks	NonStructural	Commercial	Interior + Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
106	American Standard Building System			Wall			Wall sheathing-complies with Federal Spec #LLL-I-535B	USA, Canada, Guatemala, Spain, Canary Islands, Hawaii, Korea, Taiwan, Japan, Germany, Israel, Argentina, Chile and Caribbean Islands	www.asbsystems.com emailed online form11/17	Web	
107	Sliding and Folding Wood Doors	Maximum height- 16" 4 7/8", width is approximately 1/3 of height	2 1/4"						www.hafeleamericas.com		

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
108	Wausau Homes, Inc and Sterling Building Systems	Wausau Homes and Sterling Building Systems, USA, WI	Wood-System is comprise of floor panels, interior & exterior wall panels, and roof trusses.Floor panels use solid lumber joists or I-joist, plywood or osb sheathing plant applied.Interior wall panels are open frame.Exterior wall panels are open frame on the inside surface. The outside surface has plywood, osb or foam sheathing & house-wrap plant applied, windows & entry doors plant installed with weatherization flashing.Engineered roof trusses are designed for continues load transfer and is an integral part of the whole-house design.	Building- The structural panel system is used in construction of residential homes and light commercial structures with floors, walls and roofs.	Wood- frame with panel sheathing; plywood, osb or foam.	Wood framing	Nails, spikes, plates, hangers and other conventional mechanical fasteners. Meets requirements for high wind load design and foundation anchorage.	Structural	Residential + Light Commercial	Exterior + Interior
109	Strong-Wall Shearwall	Simpson Strong Tie, USA, CA	Wood- This panel is an open wall prefabricated wood shearwall. The panel achieves high design loads proven by cyclic testing.	Building- The structural panel is used in the construction of residential exterior walls and garages. This type of panel is used when the area requires high load bearing.	Wood	Insulation- upon request	Templates locate the required holdown and mudsill anchor bolts accurately in the foundation. The walls are then placed over the anchor bolts followed by a simple top and bottom plate attachment.	Structural	Residential	Exterior

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
108	Wausau Homes, Inc and Sterling Building Systems	Floor: 8-foot wide by up to 36-foot long. Interior Walls: Full wall height and varying lengths up to 28-feet. Exterior Walls: Varying lengths up to 28-feet	Walls: Conforms to standard framing sizes; 2x4, 6,8,10 & 12. Floors: standard framing sizes; Lumber - 2x8, 10, 12 in solid lumber. I-joist - 8-in, 12-in, 14-in & 16-in	Floors, Walls and Roofs	Varies by project	Conforms to Energy Star® Homes and Green Built Homes™ as a total system science structure.	Conforms to all local, state and national model codes. Third party certification compliance.	• West, Mid-West and South East.	PO Box 8005, Bus Hwy 51/I-39, Wausau, WI 54402 Phone: 800-735-1812 Fax: 715-359-8097 Website: www.wausauhomes.com E-mail: opatikf@wausauhomes.com Frank Opatik, Vice President	TAG	Distribution is through independent builders who coordinate the on-site construction and after sale service. The building system is designed and engineered on a 3-D integrated modeling platform to assure structural integrity and generate complete bills of materials.
109	Strong-Wall Shearwall	8', 9', 10', and 12' wall heights		Walls and garages. Areas that need extra support in the event of an earthquake.			Recognized by Code Agencies, ICBO (PFC-5485), COLA (RR-25427), and California DSA (PA-110).		4120 Dublin Blvd. Suite 400 Dublin, CA 94568 800-999-5099 Fax: 925-833-1496 www.simpsonstrongwall.com	Web, toolbase	

	System Name	Manufacturer	Description	Current & Potential Application	Skin Material	Core Material	Connections	Structural / Non-Structural	Residential / Commercial / Industrial	Interior / Exterior
110	American Barn	Premier Stabling and Sectional Buildings, International, UK	Wood-Not insulated wood panels that clad externally with selected high quality Ex 19 X 125 redwood shiplap.	Agricultural- Nonstructural panel used for the construction of exterior barn walls. Redeeming value is that it is light and easy to work with.	Wood	Open wall system, no framing	Panels nailed with galvanized steel nails, and bolted together	NonStructural	Commercial	External

	System Name	Panel Size	Panel Thickness	Application Focus	Cost/ sqft	Environmental Quality	Certs	Distribution / Region	Contact Information	Info Source	Notes
110	American Barn			Barn walls					Church Farm, Kemps Road, Pulham St Mary, Diss, Norfolk, IP21 4YH. 01379 608 579 01379 608 579 info@premiersectionalbuildings.co.uk www.premiersectionalbuilding.co.uk	Web	